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UNIVERSITY OF CALIFORNIA PUBLICATIONS.

COLLEGE OF AGRICULTURE.

AGRICULTURAL EXPERIMENT STATION.

THE CALIFORNIA SUGAR INDUSTRY.

PART I.

HISTORICAL AND GENERAL.

By GEORGE W. SHAW.

BULLETIN No. 149.

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TABLE OF CONTENTS.

	Page.
INTRODUCTION	5
PRESENT MAGNITUDE OF THE SUGAR INDUSTRY IN CALIFORNIA	7
Money Value of the Product Compared with Other Products	7
List of Factories, Location, Capacity, and Money Invested	8
THE EARLY PERIOD OF THE INDUSTRY—1857-1880	8
The Pioneer Factory	8
Early Efforts to Crush the Industry	10
The Soquel Factory	11
The Isleton Factory	11
The Standard Sugar Refining Company	12
THE DORMANT PERIOD—1880-1887	12
Table Showing Field Results at Alvarado Factory	13
Early Attempts to Dry Sugar Beets	15
THE MODERN PERIOD—1888-1902	17
Results at Alvarado	18
Table of statistics	20
The Watsonville Factory	21
Table of statistics	22
The Chino Factory	24
Table of statistics	28
The Los Alamitos Factory	29
Table of statistics	29
The Crockett Factory	32
Results in 1900, 1901	32
The Oxnard Factory	34
Soils, irrigation	37
Table of statistics	39
The Salinas Factory	39
The Betteravia Factory	44
GENERAL CONSIDERATION OF THE SUGAR INDUSTRY	46
Advantages Accruing from Beet Culture	46
A Review of the 1901 Campaign, and Statistics	47
The Cost of Manufacture	50
What California Can Do in Beet Sugar	53

ILLUSTRATIONS.

	Page.
PHOTOS OF E. H. DYER AND P. C. SPRECKELS	6
ORIGINAL ALVARADO SUGAR FACTORY	9
THE ISLETON SUGAR FACTORY	9
ALVARADO BEET-SUGAR FACTORY	19
WATSONVILLE FACTORY	23
CHINO FACTORY	25
INTERIOR OF CHINO FACTORY, SHOWING DIFFUSION BATTERY	26
LOS ALAMITOS FACTORY	30
CROCKETT FACTORY	33
OXNARD FACTORY	34
ARTESIAN WELL AT OXNARD	35
VIEWS IN THE INTERIOR OF OXNARD FACTORY	36
INTERIOR OF OXNARD FACTORY	38
SPRECKELS SUGAR FACTORY AT SALINAS	41
BETTERAVIA FACTORY, SANTA MARIA VALLEY	44

INTRODUCTION.

Generally favored by nature with economic conditions adapted to the production of a high-grade sugar beet and to the successful extraction of the sugar from it, still California has not held its position as the largest producer of beet sugar in the United States, for this year she will be outranked in the amount of sugar produced by Michigan, where the industry is but five years old, and which State has natural conditions far less adapted to the industry, and notwithstanding California has more acres well adapted to the industry than any other State in the Union and has had a third of a century of experience.

Under the running title, "The California Sugar Industry," it is proposed to review the conditions as they exist in the State to-day from both the manufacturing and the agricultural standpoint, and to discuss such experimental work bearing upon this industry as has been and may be undertaken by this Experiment Station.

This first number of the series is naturally historical in a large measure. Since California is the mother State of the industry, it is fitting that its early history should be recorded in some connected manner that it may be easily accessible. Part I also presents statistical matter of much value to manufacturers and others who may be studying the subject with reference to the establishment of factories. This is particularly true as the periods covered by the reports are the longest on record in this country and cover a great variety of soils and climate.

Part II will deal mainly with a review of the present agricultural conditions and practices, and suggestions for improving the same deduced from observations in the field and laboratory.

The writer desires to acknowledge the courtesy of the sugar companies in supplying the basal figures from which the tables have been computed.

E. H. DYER,
Father of the Beet-Sugar Industry.

P. C. SPRECKELS.

THE CALIFORNIA SUGAR INDUSTRY.

PART I. HISTORICAL AND GENERAL.

California was the first of the United States to successfully manufacture beet sugar upon a commercial scale. She has placed beet sugar upon the market for the past thirty-three years. Within her borders is located not only the pioneer beet-sugar factory of this country, but also one of the largest factories in the world, both of which are in successful operation this year. California leads in the annual production of beet sugar, yet comparatively few people outside of the immediate neighborhood of the beet-growing sections have any adequate conception of the present status of the industry.

The present localities in which beets are produced for sugar purposes extend from the San Franciscan region on the north, along the coast counties, to San Bernardino County on the south. Within this area some 60,000 acres are devoted to sugar-beet growing, the product from which, under favorable conditions, represents an annual money value exceeding $6,000,000, assuming the average price to be 4½ cents per pound.

The relative importance of the industry, as compared with a few of the other leading products, may be seen from the following table, taking the reports of 1902 as the basis:

	Pounds.	Value. (at average price.)
Butter	31,528,000	$6,305,600
Potatoes	24 000,000	2,760,000
Citrus fruits	450,000,000	10,000,000
Raisins	96,000,000	5,280,000
Hops	10,670,000	1,493,800
Beet sugar	160,000,000	6,800,000
Beans	115,000,000	4,600,000
Wool	25,835,700	3,100,000
Wheat	18,580,000	12,452,000
Prunes	150,000,000	6,000,000

Thus it will be seen that the value of the beet sugar produced in the State practically equals the value of the butter product and of the prune crop; equals about three fifths of the value of the citrus fruits; more than doubles the value of the potato crop; surpasses the value of the

raisin crop by $1,000,000, and the bean crop by $2,000,000; and equals one half the value of the wheat crop.

Factories.—Eight factories are engaged in the production of this sugar, the location, year of establishment, and the capacity of each being shown in the following table:

Established in—	Locality.	County.	Operated by—	Capacity. (Tons, 24 hrs.)
1869	Alvarado[1]	Alameda	Alameda Sugar Co.	800
1888	Watsonville[2]	Santa Cruz	Spreckels Sugar Co.	1,000
1891	Chino[3]	San Bernardino	American Beet Sugar Co.	750
1897	Los Alamitos[4]	Orange	Los Alamitos Sugar Co.	700
1898	Crockett[5]	Contra Costa	Calif. and Hawaiian Refining Co.	1,200
1898	Oxnard[6]	Ventura	American Beet Sugar Co.	2,000
1899	Spreckels[7]	Monterey	Spreckels Sugar Co.	3,000
1899	Betteravia[8]	Santa Barbara	Union Sugar Co.	600
	Total capacity, tons per day			10,050

NOTE.—The small figures refer to the same numbers on the small map on the cover.

Exclusive of the land owned by these companies, the capital invested in the factories will aggregate approximately $12,000,000, to which may be added as a working capital and that invested in land, enough to raise the total amount invested by the companies themselves in the industry to about $20,000,000.

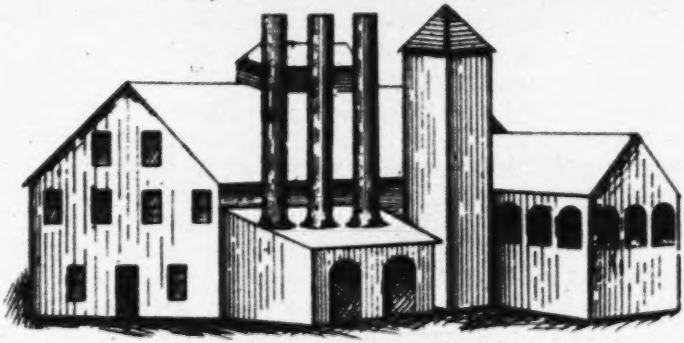
THE EARLY PERIOD OF THE INDUSTRY. (1857 TO 1880.)

The Pioneer Factory.—As early as July 20, 1857, the "California Cultivator" asks the question, "Who will pioneer the manufacture of beet sugar?" and at the same time sets forth certain advantages in California, among which may be found the "get-rich-quick" statement that "two crops can be grown annually averaging 40 to 50 tons per acre," the spirit of which the writer fears has not altogether died out, even to-day. As if to answer this query, a company was organized at San José, but no other steps were taken toward the manufacture of sugar. Although the press of the State constantly agitated the matter, yet no further active steps toward organization were taken until 1869, when Messrs. Bonesteel, Otto & Co., who at the time were engaged in a small way in the business at Fon du Lac, Wis., became associated with certain California men and organized "The California Beet Sugar Company," having a capital stock of $250,000. The stockholders of this pioneer company were C. I. Hutchinson, Flint, Bixby & Co., T. G. Phelps, E. H. Dyer, E. R. Carpentier, E. F. Dyer, W. B. Carr, W. T. Garratt, and E. G. Rollins, all of California; and A. D. Bonesteel, A. Otto, and Ewald Klinean, of Wisconsin. Immediately on the arrival of the Eastern parties, who were to assume the technical management of the business, in 1870, active operation was begun by the erection of the factory on the farm of E. F. Dyer, at Alvarado, and on November 17th, of the same

year, the first beet sugar was made in California. From that time until the present, excepting only one year, it has been annually upon the market.

This pioneer factory cost approximately $125,000, had a capacity of 50 tons per day, and turned out raw sugar at a cost of 10 cents per pound when sugar was selling at 12 to 15 cents on the San Francisco

(a) Original Alvarado Sugar Factory. Capacity, 50 Tons.



(b) The Isleton Sugar Factory. Capacity, 75 Tons.

PLATE I. TWO PIONEER SUGAR HOUSES.

market. The company paid $3.50 per ton for beets delivered, and manufactured in the first campaign 500,000 pounds of sugar. Plate I (a) shows a picture of this early factory.

The operation of this mill is described as follows: * "The beets are washed and rasped, and the juice is extracted by a centrifugal screen. Defecation is effected by lime, and purification by carbonic acid and

* Pacific Rural Press. Vol. I, No. 1.

animal charcoal. They use vacuum pans for the juice-boiling; and again centrifugals for extracting the molasses from the crystal sugar."

A year previous to the building of the Alvarado mill, "The Sacramento Valley Sugar Company" was organized by a Mr. Wardsworth, who had previously * "put up an experimental plant, and proved the fact that our beets were good for sugar; under which assurance a 70-ton plant was ordered from Germany." But subsequently the company decided to delay one year, thus losing the honor of priority. In 1871 the factory was erected at Brighton, near Sacramento, having a nominal capacity of 75 tons per day, at a total cost of $250,000, the machinery costing $160,000. Under date of November 18, 1871, the "Rural Press," in describing the mill, says, "The new factory goes into operation this week, using the diffusion system instead of the centrifugal for removing sugar." This was the first diffusion battery operated in America.

About this time the San José project again indicated life, and we find Mr. Tyler Beach, secretary of the San José Sugar Company, saying that $40,000 of the $200,000 capital stock has been subscribed.

In this same year Salinas makes its first movement toward demonstrating the possibilities of beet-sugar production by shipping 1,200 pounds of beets to the factory at Alvarado for a working test. This appears to have been the last active effort at San José, but its more fortunate neighbor now has the proud distinction of having the largest beet-sugar factory in the world.

The Alvarado factory continued to produce sugar with varying success for four years, when internal difficulties in the company arose and the Eastern parties transferred their connection to Soquel, Santa Cruz County, and together with capitalists of San Francisco there started a third factory. The Alvarado factory struggled on until 1876, when drought destroyed the entire crop, and the factory closed its doors.

The Sacramento Valley Company ran successfully in 1871, but in 1872 the beet crop was much injured by the ravages of the "army worm." The campaign of 1873 opened on August 5th and extended to November 22d, the beets showing an average of 8 per cent sugar, and an average yield of 10 tons per acre. The company manufactured 982,120 pounds of sugar, inclusive of first, second, and third grades. This factory continued to contend with army worm, grasshoppers, drought, inexperience, and opposition on the part of interested parties until 1875, when the factory closed and the machinery was offered for sale at $45,000.

Early Efforts to Crush the Industry.—It is interesting to note that the early attempts to introduce the manufacture of sugar from beets on the Pacific Coast were met with efforts to crush the industry similar to those used in the beginning of the century, when the beet first threat-

* Pacific Rural Press, Vol. I, No. 1.

ened to compete with cane for the championship of the world's sugar production (and which with the renewed interest in the industry have again been apparent during the past year); for under date of January 1, 1871, we find the following in the "Pacific Rural Press":

"Whenever any enterprise is started in this city or vicinity there is always a hard fight made by jobbers and importers to crush out the new enterprise. Of course, the beet-sugar enterprise is no exception. The first attack was a material reduction in the price of the class of sugar manufactured at Alvarado. * * * The next attempt was to frighten capital from investing in the numerous projects for other manufactories which were set on foot as soon as the success at Alvarado was made known."

The effect of these attempts may be the better realized if it be stated that at the time the factory started at Alvarado sugar was selling on the San Francisco market at 15 to 16 cents per pound, and as the beet sugar came on the market the price was suddenly put down to 11 cents; this, together with the difficulties attendant upon inexperience and lack of proper management, proved too much for the struggling company.

The importance of the manufacture attained in California is indicated by the following figures:

	Pounds.
*1870	500,000
1871	800,000
1872	1,125,000
1873	1,500,000

The Soquel Factory.—The factory at Soquel made its first sugar in 1874. There are some conflicting data as to this factory, but Mr. W. R. Radcliffe, of the "Watsonville Pajaronian," says† that the factory ran in 1876, and the "Pacific Rural Press," under date of November 10, 1877, states that "the factory was running at full capacity and the company would cut about 9,000 tons," for which they paid $4.75 per ton. The same paper states that this factory had a run of two months in 1879.

The Isleton Factory.—In 1877 the interest again revived about Sacramento, and another factory was erected at Isleton, an island in the Sacramento River ill adapted to beet culture, on account of the high water-table, the water often rising above the level of the beet fields. It should be said, however, that the original idea of the factory was the manufacture of sugar from watermelons, but this not proving feasible, attention was turned to the beet. On account of the poor agricultural conditions, the project was abandoned by the company after the first campaign in 1878. The factory had a revival for another year in 1880, during which single campaign it was under lease by Mr. H. M. Ames,

* Report of California State Agricultural Society, 1874.
† Pacific Rural Press, Vol. XIX, No. 1.

of Oakland, a stockholder in the factory at Alvarado, which company in the meantime had been reorganized, as will appear later.

The Standard Sugar Refining Co.—Thus it appears that, excepting 1887, when the Alvarado factory did not run, beet sugar has been annually on the market in California since the inception of the industry in 1870; for in 1879, overlapping the failure of the Soquel concern, the Alvarado company was reorganized by Mr. E. H. Dyer, who, believing that with proper management the business could be successfully conducted, had purchased from the old company the buildings and a portion of the land. He found it somewhat difficult to interest capital in the face of so many failures, but finally succeeded and organized the Standard Beet Sugar Company, with a capital of $100,000. For the purpose of increasing the stock to $200,000, the company very shortly reincorporated under the modified title, "The Standard Sugar Refining Company," with the following officers: O. F. Griffin, president; J. P. Dyer, vice-president; E. H. Dyer, general superintendent; W. F. Ingalls, secretary; other members of the company being R. N. Graves and G. H. Waggoner.

The year 1880 saw three factories producing sugar in California, the output from which reached the maximum for this early period. The "San Francisco Grocer" gives the following figures for that year:

	Pounds.
Standard Refinery (Alvarado)	1,574,233
Isleton factory	298,427
Soquel factory (estimated)	300,000
Total	2,172,660

THE DORMANT PERIOD. (1880 TO 1887.)

This may be said to end the early factory period of the industry in California. From this time (1880) until 1888 the factory at Alvarado was the only one to survive and keep alive the spark of interest in the United States, which in our day has kindled into a mighty flame. There is no greater evidence of the vitality of the industry than the continued existence of this pioneer factory in the face of active opposition and exposed to direct competition with the cheap products imported from Hawaiian Islands under the then existing treaty.

The continued operation of this factory in the face of the adverse conditions named, while perhaps partially accounted for by its favorable location, is undoubtedly more directly due to intelligent and close attention to the details of its various operations in the field and factory than to any other factor.

From 1880 to 1888 may well be styled the dormant period of the industry not only in California, but also in the United States generally.

Since the time of its reorganization the factory has manufactured sugar annually. The first season's run of this new company netted a clear profit of $1,411.73, which was the first money actually made in the manufacture of beet sugar in this State, and probably in the United States. This factory continued to run on a paying basis for six consecutive years, the greatest earnings for a single year being $44,782.35.

While this company did fairly well until 1884, after that date one calamity and another befell the company, and from that time until 1886 it had but a struggling existence. For the season of 1884 the company made extra exertions to induce farmers to grow beets, resulting in a great increase in acreage. All conditions for growth being favorable in that season, a very large crop was the result—larger than the factory could easily handle. A very warm winter resulted in a lowering of the sugar content of the beets that had been delivered, and finally the factory found it unprofitable to longer continue the campaign, even while it had many tons of beets on hand. During this campaign, too, hostilities commenced between the two San Francisco refineries, which completely demoralized the sugar market; and between the two unfortunate occurrences the factory failed to make a profit from this large crop. The low price of sugar continued to hold, and although the factory continued to run without financial loss until its machinery was badly damaged by the explosion of a boiler in 1886, it was unable to make a profit. The tons of beets worked and the sugar made therefrom are shown in the subjoined table; all data, except as indicated, being furnished from the books of the company:

TABLE I.

RESULTS AT ALVARADO, 1880-1888.

Campaign.	Beets Worked, Tons.	Sugar Made, Pounds.
1879-80	13,000	1,231,966
1880-81	9,226	1,186,973
1881-82	11,230	1,415,847
1882-83	10,489	1,098,583
1883-84	7,901	1,027,826
1884-85	*16,728	1,906,000
1885-86	*10,500	†1,200,000
1886-87	12,506	*1,438,000
1887-88	No beet sugar made in United States.	

At the end of the eighth year the low price of sugar and active competition, coupled with damage from a serious boiler explosion, forced the company to improve its facilities for manufacture, and in 1887 the Pacific Coast Sugar Company was organized and a new factory erected. This company operated one year, and then sold the factory to the present Alameda Sugar Company (see page 34).

* Estimated.

† Willett & Gray's Statistical Sugar Trade Journal.

The final success of this factory was mainly due to the indomitable energy of Mr. E. H. Dyer, to whom belongs the credit of inaugurating this new industry on the Pacific Coast. He still resides in close proximity to the factory and is still a stockholder, although on account of declining years, he has retired from active business life.

During this period it is important to record that through improvements in machinery and in methods of handling the juices, developed largely through adapting them to American conditions, the Dyers had been able to reduce the cost of manufacturing sugar from 10 cents per pound in 1879 to 5 cents in 1887.

The character of beets grown during this period is fairly represented by the following figures from the records of the factory:

TABLE II.

SHOWING SOME FIELD RESULTS AT ALVARADO.

Field.	Total Solids.	Sucrose.	Other Solids.	Purity Coefficient.	Remarks.
1..	16.34	13.85	2.57	83.94	Planted 315 acres; will average 15 to 20 tons per acre.
2..	16.85	14.37	2.425	85.7	Planted 10 acres; yield, 15.3 tons per acre.
3..	16.08	13.22	2.86	82.15	Planted 10 acres; yield, 23.7 tons per acre.
4..	16.20	13.70	2.57	84.186	Planted 20 acres; yield, 18 tons per acre.
5..	16.14	13.54	2.60	83.26	Planted 12 acres; yield, 20.5 tons per acre.
6..	16.70	14.2	2.50	84.50	Planted 18 acres; yield, 23 tons per acre.
7..	15.28	12.45	2.88	81.41	Planted 10 acres; yield, 15.3 tons per acre.
8..	15.96	13.62	2.31	85.50	Planted 8 acres; yield, 19 tons per acre.
9..	16.54	13.48	3.06	81.40	Planted 10 acres; yield, 17.5 tons per acre.
10..	16.22	13.57	2.65	83.62	Planted 7 acres; yield, 15 tons per acre.
11..	15.27	11.67	3.25	78.92	Planted 5 acres; yield, 26 tons per acre.
12..	17.09	14.33	2.67	84.00	Planted 20 acres; yield, 23.7 tons per acre.

One thing noticeable in this table is that the beets produced in these earlier years were fully equal in richness to those produced in Europe for a like period. The large differences in yield indicated in the table were not due so much to variation in the fertility of the soil as to unlike and irregular methods of cultivation.

In speaking of this matter Mr. Dyer says: "The experience of six years has shown that the average yield of beets per acre has steadily increased, and this increase has been due to improved agriculture alone. At first the farmers (the company does not grow beets) were largely ignorant of the correct method of beet culture, and as this ignorance disappeared the results were seen in an increase of the crop."

During this period Dr. Hilgard, of the University of California and Director of the Experiment Station, realizing the adaptability of many sections of the State to this industry which promised so much to American agriculture, repeatedly urged its introduction into the State on a more extended scale, his advocacy often meeting with active

opposition, even by parties who later became convinced of the truth of his contention and became very heavily interested financially.

That strong opposition still held toward the industry is well indicated by an article signed L. D. Wilson and published in one of the papers of that date:

*"Capital has been seduced into these ventures by plausible representation and magnificent figures. * * * Every good citizen who has a regard for the permanent prosperity of the State, whether engaged in sugar-making or not, must regret so large an expenditure of money fruitlessly. It has a dampening effect upon investment in manufacturing enterprises of more meritorious character."

But notwithstanding the attacks of the enemies of the industry, the factory at Alvarado, being favorably located and well managed, continued to do business, as will the factories of to-day when not handicapped by unfavorable economic conditions of soil, climate, and extravagant management, notwithstanding the recently ill-advised and insidious attacks of deeply interested parties.

EARLY ATTEMPTS TO DRY BEETS.

Mention should be made, before leaving this early historical period, of the interest aroused at Los Angeles in 1880 by Mr. Thomas Gennert, who had previously been connected with the enterprise in Canada and Maine. In connection with Mr. Nadeau, he hoped to grow beets and sun-dry them for preservation and transportation. Their factory, however, failed to make sugar successfully from the dried beets. The reason of the failure does not appear, but it was probably due to some imperfection of machinery or faulty manipulation, for 50 tons of the dried beets were sent to the Alvarado factory for a working test and sugar was successfully made from them; thus seeming to demonstrate the contention of Dr. E. W. Hilgard, of the University of California, who had discussed the matter in a preliminary way in the Annual Report of the Station in 1879 and again in the following year. Although attempts had been made at drying beets by artificial heat and it had been practiced to a very limited extent in Europe, yet the great expense attendant upon such drying had rendered it unprofitable, †"notwithstanding the advantage of a high purity coefficient of the extract, resulting from the fact that in that drying process a portion of the impurities of the fresh juice is rendered insoluble, and thus remain behind in the leached pulp of the fire-dried beets." These experiments are particularly interesting, inasmuch as they represent the only ones of the kind attempted in this country, and further show the character of the beets produced in this early period of the industry.

* Pacific Rural Press, Vol. XIX, No. 1.

† Report of California Experiment Station, 1879.

The first experiments in drying were conducted on a small scale in 1879 at the suggestion of Mr. Thomas Gennert. The sliced beets were dried in the open air, as fruit is dried to-day, and samples were sent to the Experiment Station for analysis.

In discussing the results in the "Pacific Rural Press," Dr. Hilgard says:

"In from three to four days, according to the conditions of the weather, the fresh beets were reduced to one fourth of their weight, and thus converted into a material containing from 56 to 63 per cent of cane sugar, which, of course, would readily bear the cost of shipment to any reasonable distance. There could be no difficulty in keeping such a material in properly prepared bins, in this climate, for years; and the extract from it was found by me to be fully up to the standard of purity observed in the fresh beet juice itself. In 1880 these experiments were repeated, unfortunately on too large a scale for an untried industry. The season was unfavorable in every respect, the sugar percentage being low and the weather at the time very cold and foggy, so as to retard the drying and render the product liable to spoiling, without special precautions for which no preparations had been made. The result was as good as could be looked for, although there was disappointment in not securing a purer product, which could have been worked with less expensive apparatus than the fresh beets. Partly in consequence of this, the process and its product were withdrawn from the supervision of the expert who had thus far managed the enterprise; and when, some months later, the bulk of the dried roots was sent to the Alvarado factory for working, it was found that the extract was excessively impure, and that only a very small product of sugar could be obtained, the cane sugar percentage having fallen to about half of the original one. Examination showed that the beet chips had undergone a partial fermentation, evidently from an exposure to dampness that could and should, as a matter of course, have been avoided by proper storage. This was the extent of the failure which, at that time, was claimed by some as disposing finally of the project of sun-drying beets in California. So far from this, it has merely shown that the rough, wholesale method of procedure for which Californian agriculturists seem to entertain a special predilection as the only 'practical' mode of doing things, can not be applied to this industry; and that, like wine-making, it requires some technical experience and reasonable care to be successful in this preliminary step of the manufacture, as in the succeeding ones. But that with some experience, and with proper appliances, this mode of conserving the raw material for the beet-sugar factories throughout the year can be made successful and profitable in California I see no reason to doubt. If so, it will constitute a special advantage for the industry that can probably be realized in few other countries."

While the matter of drying beets would appear perfectly feasible, as

indicated, yet the writer believes as a practical application it will hardly appeal to manufacturers until they secure a much larger supply than is now the case at any factory in the country. Outlying cutting-stations, combined with pipe-lines for conveying the juice to a central plant, as about Lehi, Utah, is a far more feasible industrial venture.

That the beets grown in this southern area in this early period were of good quality for sugar purposes is indicated not only by the results stated above, but also by a series of seven analyses reported by Mr. Gennert, averaging 14.7 per cent sugar and 88 per cent purity, and giving an average yield of 15.6 tons per acre.

THE MODERN PERIOD. (1888 TO 1902.)

The industry took on new life in 1888, in which year, to meet the lessened price of sugar and the competition offered by the erection of a new factory at Watsonville equipped with more modern appliances, the Alvarado factory improved its machinery, and later, in 1897, increased its capacity to 900 tons per day.

It was not, however, until the McKinley tariff, which went into effect in October, 1890, giving a bounty of 2 cents per pound on all sugar produced in the United States, that the industry could be said to be sure of a footing. Whatever may be thought of the wisdom of this step, it is certain that it gave new hope to both operators and growers, and between the time that this Act went into effect in October, 1890, and the following June, some $6,000,000 had been invested in beet-sugar factories in this country where experiments had been previously conducted. From the encouragement offered by this Act may probably be dated the really active modern period of the industry.

With the development of the factory has come the growth of other industries. When the Watsonville and Chino factories were built all the machinery had to be imported from Europe, Germany furnishing about $2,000,000 worth of machinery for four factories built during 1888 and 1891. The Yankee inventive genius of machinery men at once took hold of the matter, making so valuable improvements that both the above-mentioned factories were shortly refitted with machines of American make, and every factory in this country in the last few years has purchased American machines.

This small bounty, even for a brief time, was a wonderful stimulus to the struggling industry, and with a reasonable protection from the influx of cheap sugar from foreign ports this youthful industry will speedily reach the age of maturity and fulfill Napoleon's prediction when, in "Analyse de la Question des Sucres," he represents the beet as saying: "Respect me, for I enrich the soil; I fertilize the land, which otherwise would remain uncultivated; I employ the hands, which without me would remain idle; finally, I solve one of the greatest problems of modern society, I organize and increase labor."

RESULTS AT ALVARADO FACTORY.

The country from which the supply of beets is drawn for the Alvarado factory is one of the richest in the State. The soil is an easily cultivated sandy loam, largely subirrigated and very retentive of moisture, stretching from the bay eastward toward the hills for a distance of from five to ten miles. The climate is a peculiar one, and experience has shown it to be exceedingly well adapted to the development of a first-class beet. The planting season can be extended over a period ranging from February to well into May, thus securing a long campaign for the factory, which can usually begin operations in August and have consecutively-maturing crops of beets on which to work. The summers and the falls are generally dry and the winters mild, so there is little, if any, danger of the roots taking a second growth, and after harvest the beets need little protection. Few factories are so favorably located agriculturally as this pioneer in the industry. It is, perhaps, more certain of a reasonably good crop each year than any other factory in the State under the present conditions—unless we except the Watsonville factory—inasmuch as the precipitation (the average of which is 20 inches), even when it is deficient in the more southern areas, never falls below the point of maturing a profitable crop. The smallest average tonnage since 1888, 7.2 tons per acre, was secured in 1898, which is considered to have been the most unfavorable season since 1876–7. Again in 1900 the tonnage fell to about the same point, this also being a very dry year. Based upon the results of the last ten years the average percentage of sugar in the beets has been 13.66, and the average purity 81.7. On an average of over 3,000 acres annually there has been produced for thirteen years an average yield of 9.75 tons per acre, for which the factory has paid the farmer an average price of $4.60 per ton, thus giving a return of $46.54 per acre, including good, bad, and indifferent years. The crude sugar per acre has ranged from 3,864 pounds in 1896, when the rainfall was about 32 inches, to a minimum of 1,932 pounds in 1898, when the rainfall was but a little above 10 inches; thus showing what a great influence variations in climate from season to season may have upon the factory returns as well as upon the profit to the grower.

The season of 1901 was favorable, and from the 6,557 acres there was an average yield of 10.3 tons carrying 15.2 per cent sugar in the beet, with a purity coefficient of 81. The production of sugar from this factory was exceeded by only four factories in the country, two of these being in this State. The campaign lasted 128 days (August 19th to December 25th), during which time 67,251 tons of sugar beets were worked. It is interesting to note that from improved methods and machinery the cost of handling a ton of beets in the factory dropped from $5.28 in 1889 to $2.71 in 1897.

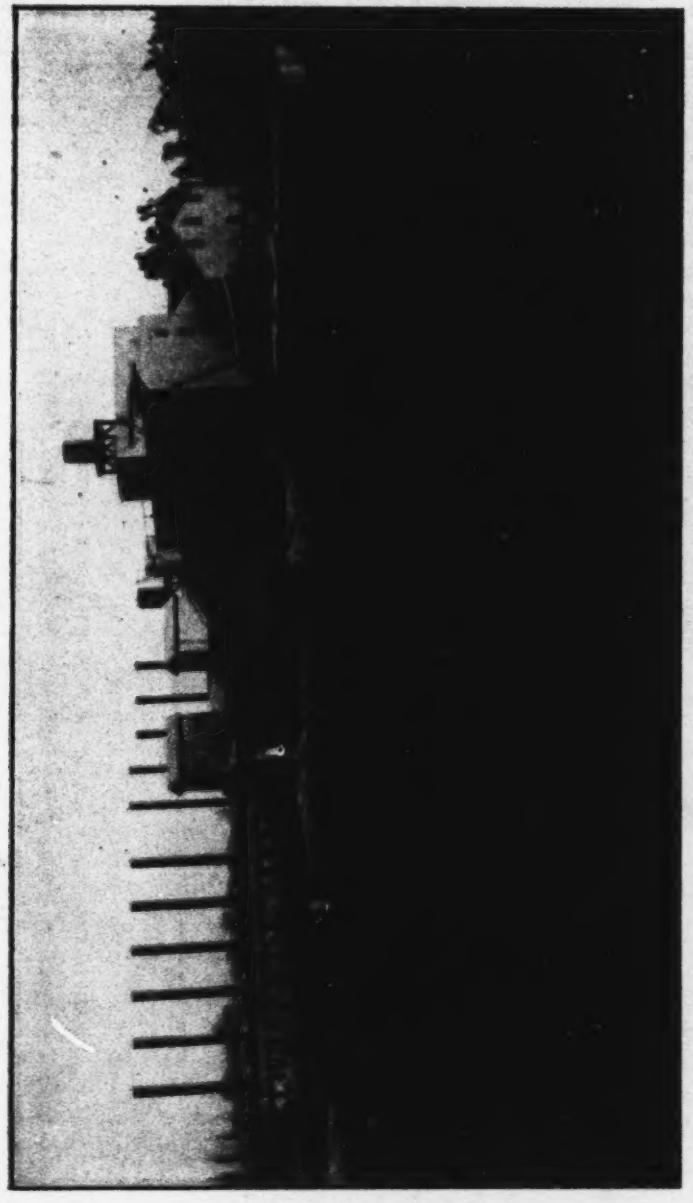


PLATE II. ALVARADO BEET-SUGAR FACTORY. CAPACITY, 600 TONS.

TABLE III.

ALVARADO FIELD AND FACTORY STATISTICS, 1889-1902.

Year.	Acres of Beets Grown.	Tons of Beets Produced.	Average Yield per Acre, Tons.	Average Price per Ton.	Total Paid for Beets.	Quality of Beets.		*Sugar.				Campaign.			Average Return per Acre.
								Per Acre.		Per Ton.					
						Sugar in Beets.	Purity.	Total Crude.	Refined.	Total Crude.	Refined.	Began.	Closed.	Days.	
1889	958	9,224	9.62	$4 54	$41,877	14.0	71.3	2,700	2,160	280	224	.....	.....	.....	$43 71
1890	1,320	13,296	10.07	4 50	59,841	14.3	83.7	2,880	2,304	286	229	.....	.....	.....	45 34
1891	949	10,942	10.47	5 00	54,710	12.0	80.0	2,420	1,936	240	192	.....	.....	.....	57 65
1892	1,594	15,060	9.40	5 23	78,921	12.53	78.12	2,356	1,885	351	281	.....	.....	....	49 51
1893	1,843	20,272	11.30	5 09	103,185	14.51	83.89	3,179	2,543	290	232	.....	.....	....	55 98
1894	2,894	39,709	13.70	4 71	187,312	11.46	80.10	3,140	2,512	229	183	.....	.....	.....	64 72
1895	2,401	27,385	11.40	4 14	113,374	13.41	80.50	3,038	2,430	266	214	.....	.....	.....	47 22
1896	3,500	48,563	13.90	4 10	199,108	13.90	81.38	3,884	3,491	278	222	.....	.....	.....	56 89
1897	4,829	49,002	10.10	4 17	204,338	14.54	85.75	2,936	2,349	291	233	.....	.....	.....	42 31
1898	5,130	36,921	7.20	4 62	170,575	13.42	82.24	1,932	1,546	268	214	Aug. 29	Nov. 20	84	33 25
1899	5,344	38,740	11.00	4 55	167,167	13.16	78.78	2,894	2,315	263	210	Sept. 11	Dec. 2	82	31 28
1900	5,515	35,993	7.30	4 60	165,568	14.54	82.29	2,120	1,696	291	233	Aug. 27	Nov. 7	73	30 02
1901	6,557	67,251	10.30	4 60	309,356	15.15	84.02	3,120	2,496	303	242	Aug. 19	Dec. 27	128	47 17
1902	5,113	48,970	9.57	4 50	220,365	16.13	84.00	3,080	2,464	322	258	Aug. 19	Nov. 27	109	43 07
Total or average..	47,947	459,425	9.70	$4 60	$2,075,696	13.70	81.5	2,788	2,220	283	226	.....	.....	.....	$46 35

*NOTE.—The figures in the four columns under this heading are estimates made by the writer. The column headed "Total Crude Sugar" is based on the average yield per acre and the per cent of sugar in the beets. The column headed "Refined Sugar" assumes that 80 per cent of the total may be obtained as white granulated sugar. This would be considered good factory work when the molasses is not reworked, but is too low an estimate when such reworking is done.

The present season has not been quite so favorable for the crop as in 1901, and only about two thirds as many beets will be cut. During the present season the company has 5,300 acres in beets, about 750 acres of which is being grown by the company itself near Pleasanton, which furnishes the bulk of beets for the earlier part of the campaign, planting in that locality being possible in February.

The number of individual growers for this factory ranges from three hundred to five hundred. These farmers have come to know the crop and to need comparatively little instruction from the factory, with the exception of the newer growers, which may also be said of those about Watsonville, only to a little less extent, with which factory it is interesting to compare the results given above. Such a comparison is particularly interesting, as these are the longest records of any beet-sugar houses in this country and illustrate what may fairly be expected from favorably-situated and well-managed factories in humid regions. The two tables show a steady development of the industry and afford the most extensive data extant for judging of the "ups and downs" of this industry, both from the standpoint of the farmer and from that of the factory.

THE WATSONVILLE FACTORY.

As previously indicated, in 1888 Claus Spreckels had been won over to the importance of the beet as a sugar producer and the adaptability of California conditions to the industry, and in company with others, under the firm name of "The Western Beet Sugar Company," erected a factory at Watsonville, Santa Cruz County, in the rich Pajaro Valley, which was soon developed into the largest factory operated in the United States, and so remained until 1898. The country about this factory is one of exceptional richness in all the elements essential to the highest returns in beet culture. In the lower part of the valley a clay loam soil predominates, and higher up an adobe, which is succeeded by a dark red loam. The favorite soil for beets is the clay loam.

This factory was also fortunately located, and has been one of the most successful in the country, although, on account of its intimate connection with the cane refinery of San Francisco, it only manufactured raw sugar, and in this respect has differed from all other beet-sugar factories in this country. Since the erection of the larger factory near Salinas, in which Mr. Spreckels is also the principal owner, the Watsonville plant has remained idle, all beets grown in that region being shipped to the larger factory, which will doubtless continue to be the case until a sufficient acreage is obtained in the immediate vicinity of the larger plant.

The following tabular record of the factory operations for a period of ten years furnishes a large amount of valuable information:

TABLE IV.

WATSONVILLE FIELD AND FACTORY STATISTICS, 1888–1898.

Year.	Acres of Beets Grown.	Tons of Beets Produced	Average Tons per Acre.	Paid per Ton.	Total Paid for Beets.	Sugar Made.				Campaign.			Average Returns Per Acre.
						Raw, Tons.	Refined, Tons.*	Per Acre, Refined.	Per Ton, Refined.	Began.	Closed.	Days.	
1888	2,100	14,845	7.07	$4 83	$70,701	.....	.....	.....	.....	.....	.....	.....	$34 15
1889	1,778	13,472	7.58	4 95	66,686	.....	.....	.....	.....	.....	.....	.....	37 52
1890	2,900	18,715	6.13	4 44	84,096	2,127	1,946	1,341	9.6	Sept. 13	Dec. 4	82	27 22
1891	1,443	19,251	13.67	5 00	96,255	2,170	1,965	2,751	9.6	Sept. 15	Nov. 20	66	68 35
1892	4,254	54,415	12.79	5 00	772,075	5,696	5,211	2,450	10.4	Aug. 31	Jan. 23	146	63 95
1893	5,156	65,306	12.68	5 00	326,986	7,769	7,009	2,757	9.1	Sept. 14	Jan. 12	120	63 40
1894	11,013	143,802	13.05	4 87	700,316	12,047	11,023	1,998	12.9	Aug. 16	Mar. 24	220	63 55
1896	7,284	77,145	10.61	4 00	308,580	10,915	9,987	2,750	7.7	Sept. 3	Dec. 14	102	42 44
1896	11,017	154,936	14.06	4 00	619,744	19,528	17,868	3,243	8.6	Aug. 12	Jan. 29	170	56 24
1897	10,306	110,786	10.75	4 00	443,144	14,888	13,622	2,643	8.1	Aug. 29	Dec. 25	118	43 00
Total or average	57,230	672,763	10.84	$4 47	$2,989,576	9,392	8,594	2,442	9.8	.....	.....	128	$49 98

* Estimated by the writer at 100 lbs. raw sugar to 91½ tons of refined.

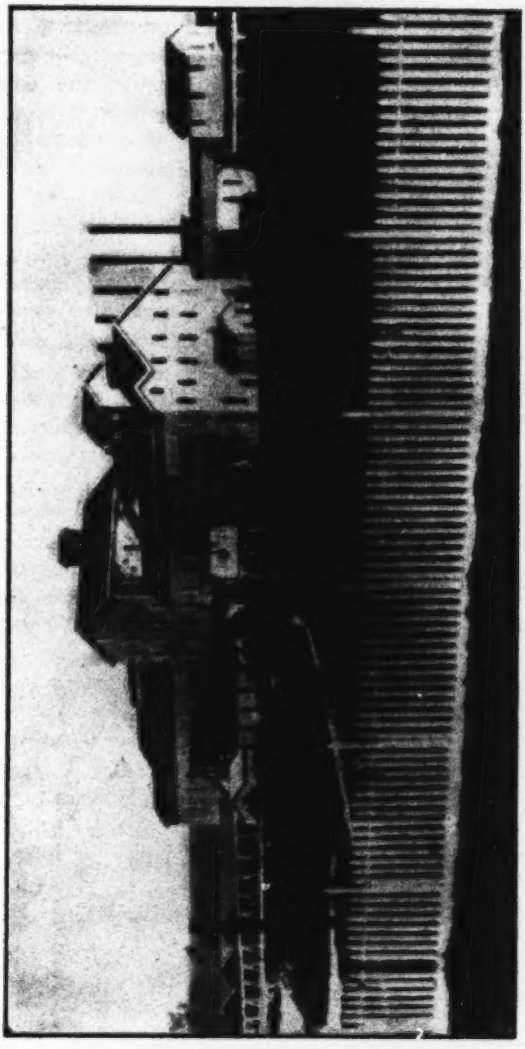


PLATE III. WATSONVILLE BEET-SUGAR FACTORY. CAPACITY, 1,000 TONS.

Including good, bad, and indifferent years, there has been an average yield of 11 tons during ten years on about 60,000 acres of beets, for which the farmers have received from $4 to $5 per ton. The returns per acre have ranged from $27 to $68, and averaged $50 for this period. As is usually the case, the profits from the crop during the first few years were small, on account of the inexperience of growers, but when once the most economical methods were learned and the land was put into an improved condition they were more than proportionately increased, and the crop proved one of the most profitable that the farmer could grow. This mill has paid nearly $800,000 in a single season for the crop.

It is interesting to note that the average of 8.9 tons of beets to make 1 ton of raw sugar is fully up to the record of the German factories for the same period, notwithstanding the fact that they have been so much longer in the business. The great variation of two succeeding years, from 7 to 12 tons of beets for 1 ton of raw sugar, while probably not altogether due to difference in quality of beets, yet must be considered as largely due to that factor, and illustrates what an influence upon the industry climatic conditions may have. The quantity of raw sugar per acre ranged from 1,466 pounds in 1890 to over 3,500 pounds in 1896, and averaged 2,700 pounds. It was in 1896, also, that the Alvarado factory secured its maximum of sugar per acre.

It is further interesting to note that the price of sugar decreased about 40 per cent during the period covered by the table, while the price paid for beets was not reduced to any material extent, and to-day, when sugar is lower than it has ever been, the price paid for beets remains practically the same.

The run of 220 days by this factory in 1894 is said to have been the longest campaign ever made by any factory in the world.

In 1898 this locality, like others, suffered from drought, but not to any great extent. As a result, however, the acreage dropped to 7,200, with a total yield of 57,761 tons, or an average of 8 tons per acre. The custom obtains here, as at Alvarado, of paying a flat price per ton for the beets, instead of using a sliding scale depending upon the sugar content of the beets. Yields of individual crops about Watsonville frequently run to 25 tons per acre, and an entire tract of 100 acres has given an average of 18 tons.

THE CHINO FACTORY.

A great impetus was given to the beet-sugar industry not only in California, but also in the United States, when in 1890 the Oxnard Brothers, who had previously been engaged in the refining business in the East, turned their attention westward, and established under the name "The Chino Sugar Company," their first factory at Chino, San

PLATE IV. CHINO BEET-SUGAR FACTORY. CAPACITY, 700 TONS.

Bernardino County, and followed this by the erection of others in Nebraska, and have since extended their operations to Colorado and Michigan. So vigorously have they pressed the business that they may be regarded to-day as the foremost champions of the sugar-beet cause, not only in California, but also in the United States. They now operate six factories, two of which are in this State.

To establish the adaptability of the soil and climate about Chino to the sugar beet, experiments had been conducted for a number of years with favorable results. These appealed to the Oxnards, and demonstrated the possibility of beet production in the locality. From a region devoted to cattle-raising, where but few people were employed, it has

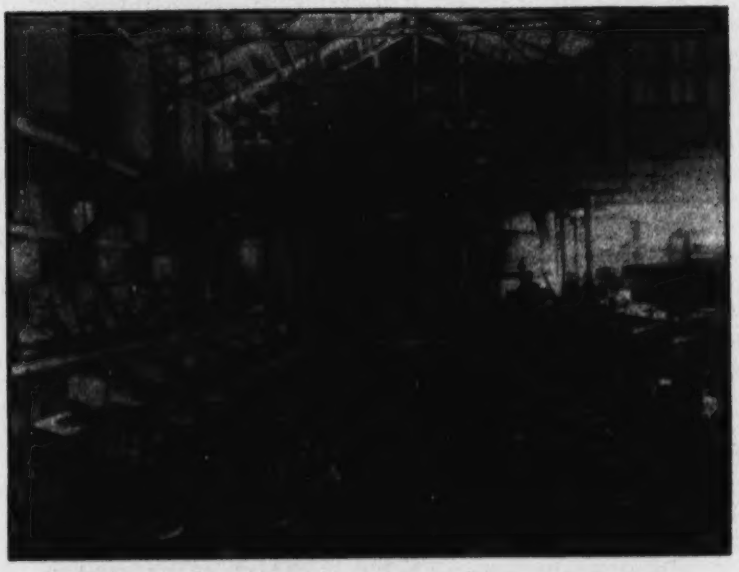


PLATE V. INTERIOR OF CHINO BEET-SUGAR FACTORY. SHOWING DIFFUSION BATTERY.

now changed to a thriving community of farms of from 10 to 40 acres, where many people have homes and furnish employment for many more. The first campaign of the factory was in 1891, when 13,086 tons of beets were received from 1,800 acres of land, for which the factory paid $51,035. This factory was continued under the name above indicated until 1898, when it was taken over by the American Beet Sugar Company, a company organised to include all of the Oxnard interest in beet sugar in the States previously named.

As in the case of Watsonville, the industry has been generally successful at Chino, excepting only the three years of exceeding drought. The region being so much farther south is more subject to drought con-

ditions than those previously discussed, and greater precaution is necessary to retain the natural moisture in the soil. The average returns on 64,435 acres and covering twelve years have been over $40 per acre, and if the first two years in which the farmers were learning the industry and its adaptability to the different soils be excepted, the returns per acre have averaged near $45, which compares favorably with any other crop of the region. The mill has paid for beets as high as $430,000 in a single season. The average per cent of sugar has been 14.6, and the price $4.41 per ton. There has been an encouraging increase in the total acreage planted, especially when it is remembered that a rotation has been lately introduced and that dairying and alfalfa-growing have been carried on in the locality to quite an extent. The region has some difficulties to contend with in the way of black alkali and hardpan land, which is not the case in either of the localities previously described. These local peculiarities tend to accentuate any unfavorable moisture conditions, especially when beets are upon alkali soils.*

During the past season the conditions approximated the normal and there was a heavy tonnage. From 8,822 acres harvested 97,605 tons of beets were produced, an average of 11 tons per acre. Of the total acreage the company itself grew about 400 acres. The sugar content in this region is never high, but quite constant; and the purity is generally lower than in the other localities, which may probably be traced to the higher per cent of soluble salts in the soil.

The beets immediately about Chino are grown for the most part without irrigation, but about Anaheim and Compton, which furnish about 1,000 acres, irrigation is practiced to a greater or less extent.

It does not appear that what falling off there has been in the acreage contracted by individual farmers has been due to any particular dissatisfaction with the crop, but rather to a combination of circumstances, some of which may even indicate a more healthy condition of the country and may ultimately lead to a greater stability of the industry. The causes leading to this may be named in order of importance, as follows:

(1) A series of dry years, which affected, as indicated previously, all sections of the State, but most seriously of all the portion south of Tehachapi.

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*The unfavorable effects of soluble salts, especially common salt, upon the sugar content of beets, are well understood in Europe and soils showing any obvious symptoms of salinity are excluded from sugar-beet culture. Experiments at the Chino substation tract have shown that the alkali of that region, mainly sulfate of soda, is not nearly as injurious to the sugar content as common salt; so that very satisfactory roots have been produced on land which, according to European views, would be held as wholly unadapted to sugar-beet culture. While unquestionably the sodic sulfate is less injurious than common salt, climatic factors also come to the aid of the sugar beet, in that at the time of sugar formation the alkali salts are out of the reach of the active absorbing rootlets; being accumulated within a few inches of the soil surface by evaporation, while the subsoil is almost free from salts.—E. W. H.

TABLE V.

Chino Field and Factory Statistics, 1891-1901.

Year.	Acres of Beets Grown.	Tons of Beets Produced.	Average Yield per Acre, Tons.	Average Price per Ton.	Total Paid for Beets.	Sugar in Beets, Per cent.	*Sugar.				Campaign.			Average Return per Acre.
							Per acre of Beets.		Per ton of Beets.					
							Crude, lbs.	Refined, lbs.	Crude, lbs.	Refined, lbs.	Began.	Closed.	Days.	
1890-91	1,900	13,086	7.21	$3 90	$51,035	13.2	1,903	1,522	264	211	Aug. 20	Oct. 31	73	$28 35
1891-92	3,803	26,368	7.14	4 26	112,328	14.5	2,070	1,656	290	232	July 15	Oct. 11	91	30 41
1892-93	4,887	50,238	10.28	4 19	210,497	13.2	2,712	2,170	264	211	July 31	Nov. 4	97	41 02
1893-94	4,778	44,530	9.32	4 57	203,502	14.4	2,684	2,147	288	230	Aug. 2	Oct. 24	85	42 59
1894-95	7,730	85,578	11.07	4 23	361,994	14.5	3,210	2,568	290	232	July 9	Nov. 14	129	46 83
1895-96	7,348	64,001	8.71	3 83	245,124	14.3	2,491	1,993	286	229	July 30	Oct. 27	90	33 63
1896-97	10,486	97,214	9.27	4 44	431,630	15.4	2,854	2,283	308	246	July 17	Dec. 10	146	41 16
1897-98	5,339	46,770	8.76	4 56	213,271	15.1	2,644	2,115	302	242	Aug. 16	Nov. 5	79	39 75
1898-99	2,525	a 50,226	4.05	5 40	55,220	d 17.4	1,409	1,127	348	278	Aug. 26	Oct. 30	66	21 47
1899-1900	1,220	b 4,157	3.38	4 15	17,251	14.5	980	784	290	232	July 25	Sept. 6	42	14 02
1900-01	5,797	c 48,579	8.38	5 03	244,352	14.2	2,378	1,902	284	227	Aug. 2	Dec. 1	120	42 14
1901-02	8,822	97,605	11.06	4 36	427,509	14.2	1,386	1,109	284	227	.....	.....	.....	48 22
Total or average	64,435	588,352	8.22	$4 41	$2,676,713	14.6	2,400	1,920	292	233	.....	.....	.....	$41 51

a In addition, received from Oxnard 24,510 tons.
b Did not operate; beets shipped to Oxnard.
c Of which 24,662 tons were shipped to Oxnard.
d Including 24,510 tons of Oxnard beets, weight included in average.
* Estimated by the writer.

(2) The introduction of a three-year system of rotation: beets, barley, and rape, the latter being introduced as a green-manure crop.

(3) The encroachments of dairy farming and alfalfa-growing.

The first is a condition which may well demand the serious consideration of the sugar people, and will be discussed in another portion of this series.

The other two factors in reducing the individual acreage may probably be looked upon as a sign of advancement in the region, which will ultimately redound to the interest of the beet-sugar industry by keeping the land in better condition and introducing another industry that will work very closely with it.

THE LOS ALAMITOS FACTORY.

The Los Alamitos Sugar Company was organized in 1887 by W. A. & J. Ross Clarke, of Butte, Montana. The factory was built and made its first sugar in the same year. Los Alamitos is located about thirty miles southeast of Los Angeles. The Bixby Land Company, who were, and still are, the principal land-owners in the region, contracted to supply the sugar company with beets for a series of years. The capacity of the factory for the first campaign was 350 tons per day, but in 1898 it was increased to 700 tons. The factory is substantially built after the Dyer pattern, and is well equipped for the successful and economical manufacture of sugar. The soil of this locality at the time of the location of the factory was in a virgin condition and had been little used, except for the production of grass for pasturage. In the first year 3,000 acres were broken and put into beets. Within six months a town of five hundred people with comfortable homes sprang up about the factory.

The first campaign was a successful one in every sense, 29,542 tons of beets, with a sugar percentage of 15.73 and a purity of 82, coming from 2,800 acres of land, or an average of 10.5 tons per acre. From these was made a little over 6,000,000 pounds of granulated sugar, or 2,143 pounds per acre. The average returns per acre were $43.68. During this first season a number of crops ran over 20 per cent sugar in the beet.

The subjoined table shows the tons of beets and their quality for the several years the factory has operated:

TABLE VI.

STATISTICS OF LOS ALAMITOS FACTORY.

Year.	Tons of Beets Cut.	Sugar in Beets.	Purity.	Length of Campaign.
1897	29,542	15.73	81.99	120 days.
1898	2,884	15.08	79.65	7 "
1899	11,686	16.43	82.60	29 "
1900	7,501	17.55	82.18	31 "
1901	56,006	17.06	82.80	181 "
1902	42,000	16.90	82.00	.....

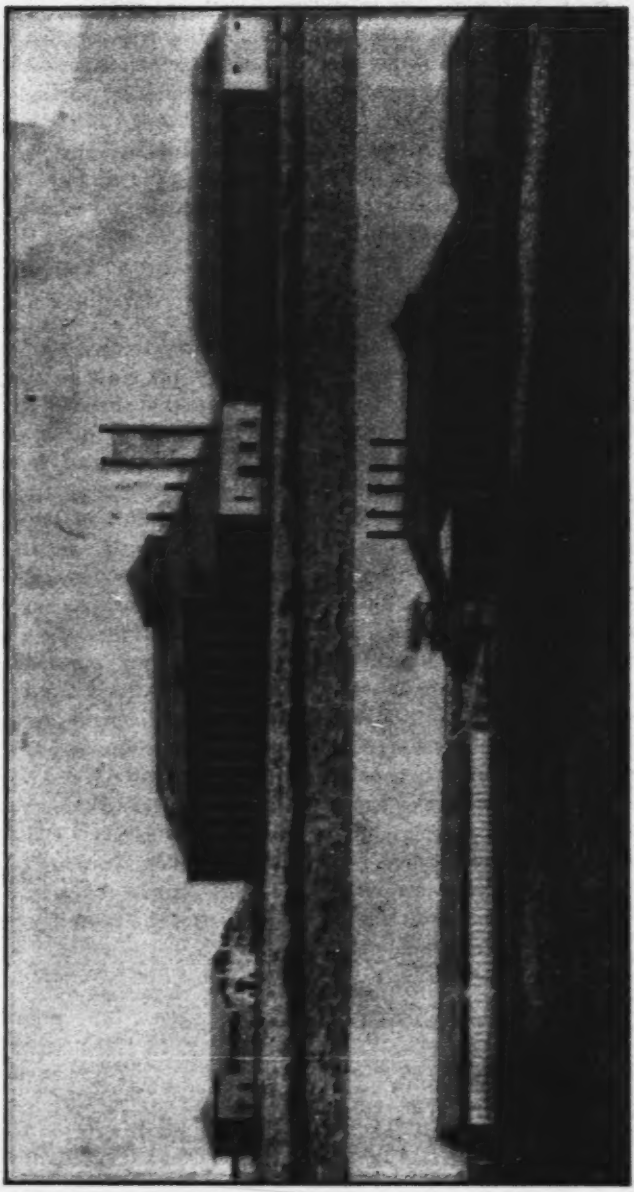

PLATE VI. LOS ALAMITOS BEET-SUGAR FACTORY. CAPACITY, 700 TONS.

During the drought period of 1898–1901, this factory suffered perhaps more heavily than any other in the State except one, which may partially be accounted for from the fact that the industry was entirely new in the region and the beets were not planted on the more moist land in all cases, and all beets located on the more sandy soils were ruined. The results at this factory have not been as encouraging as might be expected had attention been given to securing a water supply for irrigation of the crop. Notwithstanding the success that has attended the growing of beets by irrigation in Utah and Colorado, there seems to be something of an antipathy to the practice in this State; but to one unprejudiced in the matter it would seem to be the essential factor for permanent success in this industry, at least in the southern part of the State. At present the governing conditions for a crop in this locality seem to be a rainfall of from 8 to 10 inches in January, February, and March, and so distributed that there is practically no "run off." In 1898–1900 these conditions were far from being realized, which resulted in a greatly reduced crop.

The 56,005 tons of beets cut in 1901 were produced on 6,000 acres of land, thus giving an average yield of 9.3 tons per acre, with an average sugar content of 17.2 and a purity coefficient of 82.5, which brought an average price of $4.50 per ton, or a total of $252,000 paid to the farmers for the crop. The average returns per acre were $41.85; the granulated sugar produced per acre 2,000 pounds, 1 ton of beets yielding 214 pounds of sugar. In 1902 the results were not quite equal to those of 1901, in either quality or quantity of beets. The average return from 5,900 acres was $38.50 per acre and 16.9 per cent sugar in the beet.

In the intermediate years between 1897 and 1901 the acreage grown and the yield per acre were quite small, because of the drought, and should not be taken as a fair index of what the locality can do in beet production. The figures plainly show that high-grade beets can be produced; but unless the moisture conditions can be rendered certain the crop is likely to be an uncertain one in this locality. For this reason a strong and united effort on the part of both growers and manufacturers should be made to develop to the greatest extent possible the abundance of artesian water which evidently lies at the comparatively small depth of from 300 to 600 feet. Already the Bixby Land Company has some twenty-five flowing wells upon its land, and is preparing to irrigate extensively. With the introduction of an extensive irrigation practice investigations should be made as to the best methods for the application of water, for some of the lands are inclined to be quite alkali in character, and unless attention be given to this phase trouble may be experienced from the rise of alkali. Beets should be kept on the more moist lands, avoiding, so far as possible, the more sandy soils. An increase of humus in the soil is also desirable, and the introduction of green-manure

crops in alternation with beets would materially improve the conditions for beet culture by rendering the soil more retentive of moisture. These matters will be more fully discussed in Part II of this series.

THE CROCKETT FACTORY.

The next factory erected in California was at Crockett, Contra Costa County, by the California and Hawaiian Sugar Refining Company. The factory has a capacity of 1,200 tons of beets per day. The company devotes the principal part of the year to the refining of cane sugar brought from the Hawaiian Islands. Its supply of beets is not drawn from the immediate locality of the factory, but from lands owned or leased by the company, which at present grows practically its entire supply in several widely separated regions, viz: Bethany, San Joaquin County; Suisun and Cordelia, Solano County; Reclamation, Sonoma County; and Concord and Osage, Contra Costa County.

The factory, having been built in 1897, has had nothing like a fair field for securing normal results until 1901. The results of the 1900 and 1901 campaign are shown below:

TABLE VII.

RESULTS AT CROCKETT, 1900–1902.

	1900.	1901.	1902.
Campaign began	Aug. 1	Aug. 15	Aug. 15
Campaign ended	Oct. 15	Nov. 10	Nov. 6
Days of actual operation	15	86	82
Acres of beets planted	5,800		
Acres of beets harvested	2,500	5,183	5,046
Tons of beets worked	8,704	25,112	36,894
Average yield, tons	3.5	4.8	7.3
Average sugar content of beets, per cent	19.4	17.5	19 6
Average purity of juice, per cent	81.6	80.9	83.2
Sugar produced, tons	1,228.7	3,083	*5,870

* Estimated by the writer.

While in 1901 the conditions were somewhat adverse to the highest crop production, the poor general showing in that year may be largely accounted for by the selection of land at the outset which was either poorly adapted or entirely unadapted to the crop. Much of this has since been replaced by better land, and in 1902 the crop was much improved, as can be seen from the table. The experience of this company in the production of beets is a standing example for those who may enter the industry later, that it is not every locality which is adapted to the production of sugar beets, however good shallow-rooting crops it may produce.

PLATE VII. CROCKETT BEET-SUGAR FACTORY. CAPACITY, 1,500 TONS.

THE OXNARD FACTORY.

In 1897 the Oxnards, under the name of the "Pacific Beet Sugar Company," began the erection of a 2,000-ton plant at a small town now

PLATE VIII. OXNARD BEET-SUGAR FACTORY. CAPACITY, 2,000 TONS.

called Oxnard, in the Santa Clara valley of Ventura County, some three and a half miles from the ocean, which town was called into being by

reason of the factory being located there, and now bids fair to become a model city with all modern improvements.

With the organization of the "American Beet Sugar Company," which took all the factories operated by the Oxnards, this factory passed to that company and is now operated by the former.

Ventura County lies along the coast north and west of Los Angeles and east of Santa Barbara. The region is noted for the fertility of its soils, which in numerous instances have been cropped steadily for thirty years without fertilization and are still producing remunerative

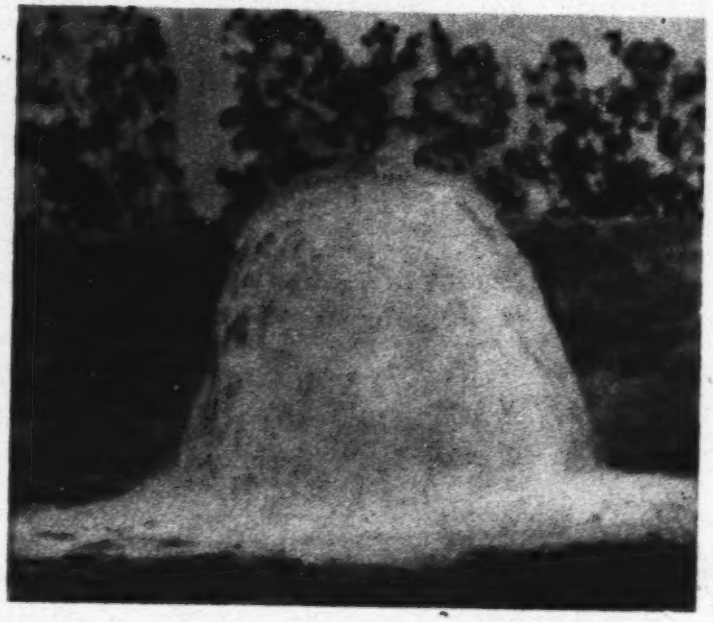

PLATE IX. ARTESIAN WELL AT OXNARD.

returns. Along the streams which break the generally rugged surface of the county, nestle many small valleys, some high and broken, others low and level, but all fertile. The climatic conditions of the valley are somewhat unique. In general the land is only a few feet above the level of the sea, and the physical characteristics of the soil are such as to render them very retentive of moisture precipitated during the winter months, and lying so close to the sea the natural humidity of the air reduces evaporation to a minimum. Heavy night fogs are the rule during the growing season, which serve in a measure to replace the little evaporation that does take place. The rainfall has usually been sufficient for the profitable cultivation of crops without resorting to irriga-

tion. The heaviest precipitation during a period of twenty-seven years was 38.4 inches, in 1884; and the lightest, 5.84 inches, in 1898. The normal is about 16 inches. The temperature is equable, the range for the growing season being 34° to 68°.

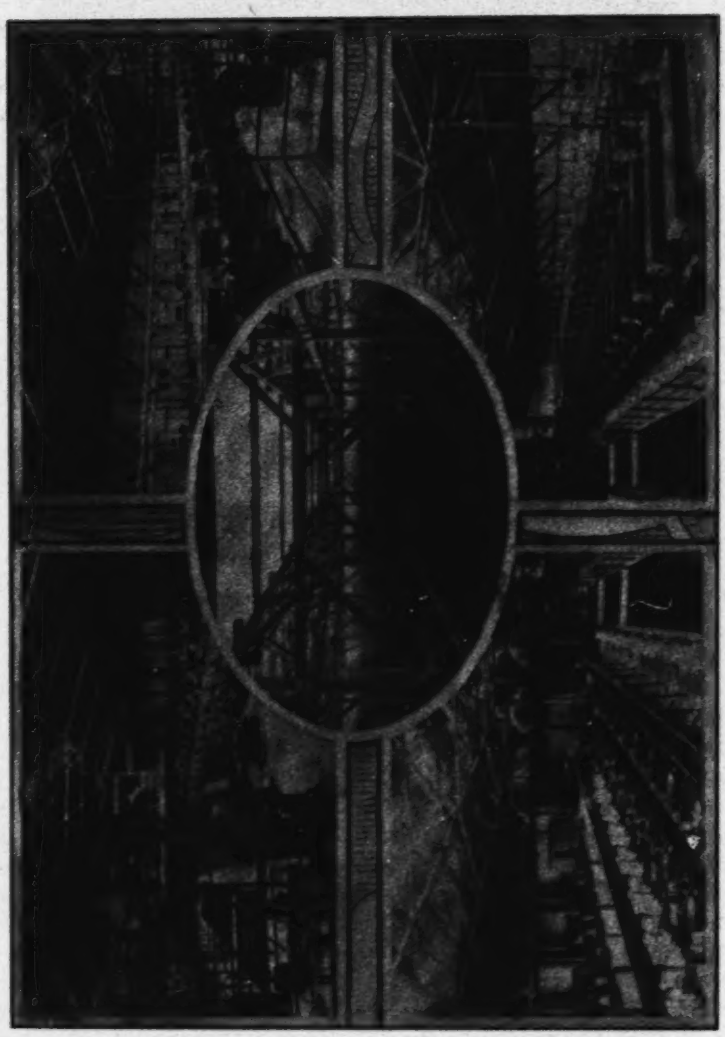

PLATE X. VIEWS IN THE INTERIOR OF OXNARD BEET-SUGAR FACTORY.

Should future experience show the rainfall to be too uncertain for the crop, the ease with which flowing artesian water can be reached at from 130 to 250 feet will solve the problem of an abundant water supply that will render the farmers independent of rainfall.

Along the shore and close to the streams the soil is a light sandy loam, and on the low-lying mesas is inclined to a heavy clay. Between these two extremes are found all intermediate grades. In general, the soil can be called a medium sandy loam, rich and deep.

It is considered by the company that there are some 60,000 acres of good beet land tributary to this factory within a radius of twenty-five miles, of which about 20,000 acres are considered first class (capable of producing 15 tons or over per acre); 25,000 acres second class (capable of producing 8 to 12 tons per acre); the balance as third class, some of which is light sandy soil, somewhat alkali in character—in some cases gravelly—but which, properly handled and in favorable seasons, will give good returns if planted to beets. The better class of land is valued at from $150 to $300 per acre; the second class at from $100 to $150; and the lighter soils at $75. The rental of land for beet-growing ranges from one fifth to one third of the crop, depending upon its character. In addition to sugar beets, the principal crops are lima beans, grain, alfalfa, and English walnuts.

The value of irrigation not only for beets, but also for other crops, is rapidly being realized, notwithstanding the usually fair moisture conditions of the region, and some experiments have been tried in the irrigation of beets down the rows, as practiced in Utah for years and in Colorado for a less time, with so much success. The experiments proved very successful, bringing an increased yield of 3 to 4 tons per acre. It is anticipated that the method will be largely increased. In the opinion of the writer, based on wide observation and experience, it is the only method of applying water to the beet crop that will meet with favor for any length of time, as giving the highest returns in yield and ease of cultivation. On land properly prepared it is remarkable as to the rapidity with which the work can be done. Farmers growing beets within a radius of the Santa Clara ditch system, or within the range of an artesian well, should avail themselves of a trial of this method, and can rest assured that the effect will abundantly repay them.

For a further discussion of this subject the reader is referred to Part II of this series, which will appear later.

The factory is well called the "Model beet-sugar factory of America," for while it may be surpassed in capacity it certainly is not in perfection of appointment. Under one colossal roof can be found machine and repair shop, engine-room, lime-grinding mills, an electric plant, ice manufactory, and scale and store rooms, all accessory to the main work of sugar manufacture. The beets are received in four parallel sheds or bins of regulation form, each 350 feet long and holding 1,000 tons each. The beets are unloaded by means of nets, on which, resting in the wagon, the beets are placed in the field. At the factory the nets are grasped on one side by iron hooks attached to a beam above, and by means of block

and tackle connected with power, the beets are bodily dumped into the bin. The main building of brick rises 93 feet above the foundation and extends 400 feet in length. Connected with the main building by a corridor is a fine three-story edifice, in which are located the offices and extensive laboratories.

In the boiler-house, 100 by 300 feet, at the rear of the factory proper, are twenty-eight steam boilers—eight high-pressure and twenty low-pressure—of 7,000 horsepower, burning crude oil as fuel; this is supplied to them through iron tanks located some 230 yards away, and which hold 30,000 barrels each.

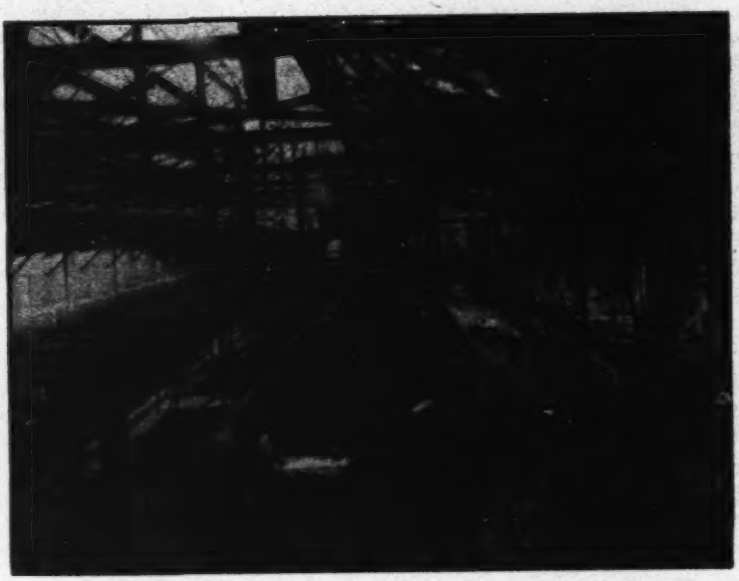

PLATE XI. INTERIOR OF OXNARD BEET-SUGAR FACTORY.

At the rear of the factory and connected with it are two immense limekilns, one rising to a vertical height of 95 feet, for burning limestone, and the other a revolving horizontal kiln for reburning lime from the factory. The vertical kiln and the twin steel smokestacks, each 36 feet in circumference and 154 feet high, stand as imposing landmarks for miles around.

The factory was intended to work the crop of 1898, but owing to the drought of that year the company decided to ship the beets to Chino, and the factory did not make its first campaign until 1899.

TABLE IX.

RESULTS AT OXNARD, 1897, 1900-1902.

	1897.	1900.	1901.	1902.	Average or Total.
Acres of beets harvested	11,442	6,238	11,892	17,690	46,762
Tons of beets produced	a 94,902	b 63,010	c 139,484	d 176,512	483,908
Average yield per acre, tons	8.30	10.12	12.23	9.98	10.2
Total amount paid farmers for beets	$438,447	$190,558	$673,708	$849,023	$887,934
Average price per ton	$4 62	$4 77	$4 83	$4 81	$4 77
Sugar in beets, per cent	17.5	17.8	16.4	15.8	16.9
Purity coefficient	81.6	81.0	82.7	79.8	81.2
*Crude sugar per acre, lbs.	2,904	3,603	2,006	3,164	2,919
*Refined sugar per acre, lbs.	2,328	2,882	1,605	2,531	2,335
*Crude sugar per ton of beets, lbs.	350	356	328	316	337
*Refined sugar per ton of beets, lbs.	280	285	262	253	270
Campaign began	Aug. 8	Aug. 15	July 11	July 19	.....
Campaign closed	Oct. 17	Oct. 18	Nov. 9	Dec. 1	.....
Length of campaign, days	61	65	122	134	.....
Average returns per acre	$38 35	$48 26	$59 08	$47 90	$48 19

a Of which 34,510 tons were shipped to Chino.
b In addition to which we received from Chino 4,154 tons.
c In addition to which we received from Chino 24,376 tons.
d In addition to which we received from Chino 12,206 tons.
* Estimated by the writer.

A particular point to note here is the very high average sugar percentage. The company, at present, pays upon a sliding scale, the price depending upon the sugar content of the beets, and in consequence a small yield in tons is usually offset by a richer beet, which brings a larger price per ton, provided always that this lessened tonnage has not resulted from a too scattering stand or from a diseased condition of the beets.

For the four years the factory has been in operation the average yield has been 10.16 tons per acre on 46,769 acres, and the average price per ton $4.77, thus giving an average return per acre of $48.19, and it will be remembered that this period includes two of the so-called "dry years." The crop for 1902 gave a total of more beets, but not so large an average yield as in 1901. Still the returns per acre were fair, when measured by most other farm crops.

THE SALINAS FACTORY.

While the erection of the immense plant near Salinas, at a place now known as Spreckels, by the Spreckels Sugar Company, which also controls the Watsonville factory, was begun in 1897, it, like the Oxnard factory, did not operate until the following year, the beets being worked at Watsonville. California is noted for doing things on a large scale, and in keeping with this, Mr. Spreckels has erected here the largest beet-sugar house under one roof in the world. The factory has a total rated

capacity of 3,000 tons of beets per twenty-four hours. It practically consists of four sets of machinery under one roof. The factory itself is a model of mechanical ingenuity, and while the plant at Oxnard was erected in the same year, yet this factory represents an entirely different type of construction.

Of more than passing interest on account of its size, it demands a brief description:

The main building is of steel and brick construction, 582 feet long, 102 feet wide, and five stories high. It is divided into three parts, the beet end of the house containing the four beet-screws, beet-washers, four beet-elevators, four beet-scales, eight cutters, fifty-six diffusion cells, in four batteries of fourteen cells each, four weighing tanks, five first saturation tanks, four second saturation tanks, filter presses, and the various heaters and pumps.

In the center of the building are the two sets of immense quadruple-effect evaporators, side by side, with an additional set of double-effect evaporators, while in the sugar end are found the vacuum-pan tanks, the seven 14-foot vacuum-pans, 28–48 inch centrifugal machines, forty-nine crystallizers, seven mixers, three sugar-hoppers, nine sugar-packers, nine sugar-conveyors, nine sack-conveyors from the scales to the railroad platform, all automatically handled.

The engine-room occupies the central part of the immense building on the ground floor, and contains five vacuum pumps (flywheels 20 feet in diameter), two gas pumps (flywheels 20 feet in diameter), six sugar pumps, one beet engine (400 horsepower), one centrifugal engine (400 horsepower), four electric generators direct-connected (two of 400 horsepower and two of 700 horsepower).

Situated next to the main building on the east is the boiler-house, 559 feet long, 68 feet wide, and 32 feet high. Here are to be found forty-eight water boilers of 125 horsepower each, four economizers, two limekilns (14 feet diameter, 50 feet high), four gas washers, one lime elevator, three lime mixers, two lime settling-tanks, one lime pump for milk or lime, four feed pumps for 160 pounds pressure per square inch; and connected with this immense boiler plant are the two steel stacks, each 216 feet high and 13 feet in diameter, each stack weighing, with its brick lining and base, 1,000 tons.

Next comes the machine shop, carpenter shop, and storeroom, 559 feet long, 40 feet wide, 32 feet high. The three buildings are of fireproof construction throughout; no woodwork except the sheathing underneath the slate on the roof. All floors are made of concrete.

The fuel used is oil, of which 1,200 barrels are consumed every twenty-four hours.

Two oil tanks are provided for storage, each 77 feet in diameter by 25 feet high, each having a capacity of 20,000 barrels or 850,000 gallons.

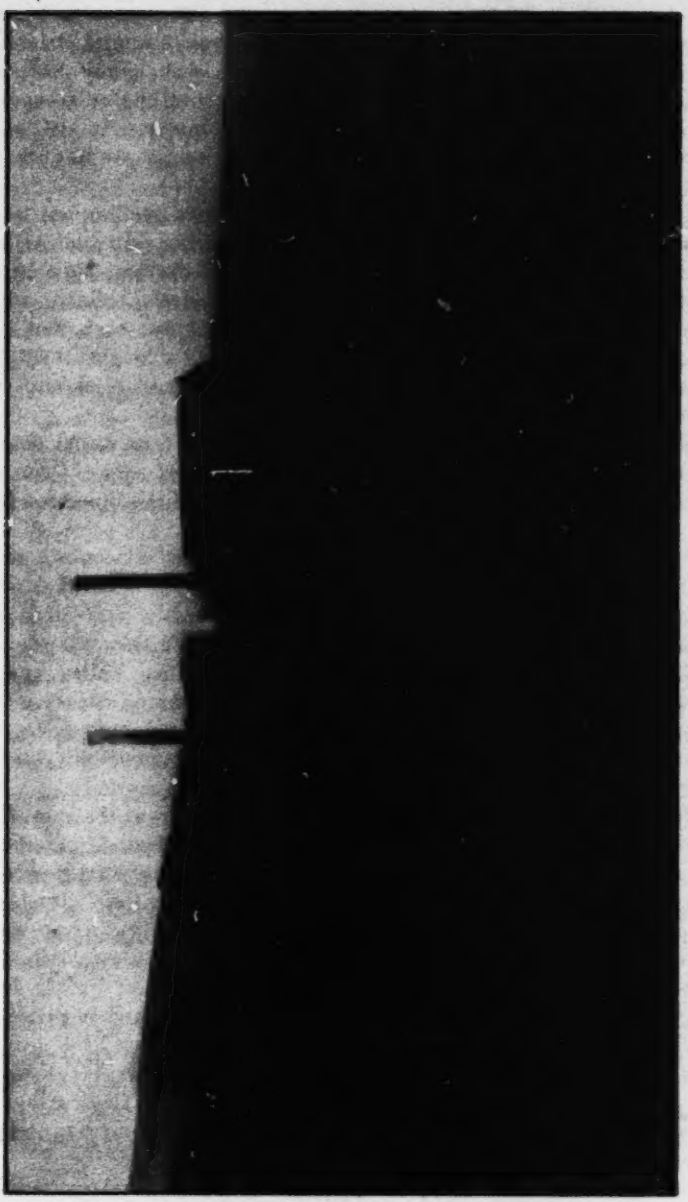

PLATE XII. SPRECKELS BEET-SUGAR FACTORY AT SALINAS. CAPACITY, 1,000 TONS.

Water is provided partly from six wells, 48 inches in diameter and 160 feet deep, each giving an abundance of beautiful clear water, and partly from the Salinas River, whence it is pumped through a mile of 32-inch steel riveted pipe by two centrifugal pumps, each pump having a capacity of 10,000,000 gallons per twenty-four hours, and each operated by a 200 horsepower direct-connected electric motor. In all, about 13,000 gallons is the daily consumption, though pumps are in duplicate and can handle twice that quantity.

At the extreme end of the boiler-house, in a third section, but under its roof, has been erected an innovation in engineering skill and mechanical work, which is in operation in Salinas for the first time in the world. This new idea consists of two enormous steel limekilns, which stand upon an open iron framework base, some 4 feet high, and then tower up through a circular opening in the roof to a height of 52 feet. These kilns are 15 feet 6 inches in diameter, lined with brick and concrete.

Thirty feet above the kilns, or 86 feet in the air, is an aërial electric railway, 640 feet long, supported by spans of 140 feet each. Over this railway, in buckets of five-ton capacity, is conveyed the limestone from the river bank to the top of the kilns.

The country tributary to this factory is estimated to contain about 90,000 acres suitable for the production of beets. The selection of this valley as a site for this immense plant was the result of years of experimenting on the part of Mr. Claus Spreckels. The Watsonville factory had for years received many beets from the Salinas Valley, and on account of the generally excellent results from there, attention was directed toward it as being exceedingly well adapted to beet culture. Vast tracts were purchased and have been subdivided into small farms, which are leased to growers on the share system.

The great Salinas Valley, some 15 miles wide at Salinas City, embraces about 640,000 acres of agricultural land, which is practically all of the arable land in Monterey County. Of this there are now some 185,000 acres under cultivation. In point of fertility the valley is not surpassed by any other in the State. Along the Salinas River, which traverses the valley, and the other streams, the soil is a very rich dark alluvium, which farther back gives place to a somewhat lighter loam, very deep and easily worked; then come tablelands highly prized for grain culture; and finally the uplands.

Until the introduction of beet culture, barley, wheat, potatoes, and white beans were the principal crops of the region, the barley and potatoes being principally grown upon the lower land and wheat upon the benchland.

In a continuous record of twenty-eight years, the temperature has never reached 100° as a maximum, nor has it fallen below 20° as a

minimum. The rainfall is normally 13.50 inches, practically all coming in December, January, and February. Sometimes it is over 20 inches, and has reached as high as 27 inches. The moisture conditions here also include heavy sea fogs, but in a somewhat less degree than at Watsonville and Oxnard.

The soil is rich in humus and very retentive of moisture. On this account and because the rainfall is generally sufficient to mature a crop, irrigation has not been much practiced, but, as at Oxnard, is bound to become a factor in beet-growing, and in a crude way is even now being more or less resorted to in a few cases.

The officials of the company declined to give the figures upon which to base tables similar to those which have preceded, and the writer has, therefore, been obliged to seek such information as possible from other sources which he deemed reliable. It is believed that the data given are to be relied upon as giving a very close idea as to the capabilities of the region and the extent of the industry which has been developed.

Several smaller valleys leading off from the larger one furnish many beets for this great factory; for example, in 1901 and 1902 beets for the factory were received as follows:

	1901.	1902.
Salinas Valley	141,280 tons	96,543 tons
Pajaro Valley	85,910 "	59,747 "
San Juan Valley	27,620 "	31,574 "
Santa Clara Valley	16,512 "	10,184 "
Totals	271,322 "	197,948 "

The beets in 1901 averaged 16.5 per cent sugar, purity 82.5, and brought $4.50 per ton at the factory, or $1,153,118, and from them was made about 57,400,000 pounds of sugar. The campaign began September 5th and continued until January 8th—122 days. The average yield was 13.8 tons per acre, giving a return of $62.10. Estimating the sugar per acre and per ton in the same manner as in the former cases, we have:

Crude sugar per acre	4,400 lbs.
Refined sugar per acre	3,630 "
Crude sugar per ton of beets	330 "
Refined sugar per ton of beets	264 "

The tonnage for 1902 was 197,948 from 17,530 acres of land, from which was made 21,607 tons of sugar, the price for beets being $4.50 per ton. The campaign extended from September 9th to December 22d.

In the first campaign the factory sliced about 175,000 tons of beets, but in 1900 the crop was damaged by drought, and still more seriously injured by a disease of the plants, which is supposed to have been induced by the exceedingly dry weather of that season.

THE BETTERAVIA FACTORY.

The last factory built in the State was by the Union Sugar Company at Betteravia, a town in the Santa Maria Valley, Santa Barbara County, called into existence by reason of the location of the factory there, in the dry year of 1899. The company was organized by the same parties interested in the Alvarado factory. The factory has a rated capacity of 500 tons per day, but with a building so arranged as to admit of doubling the capacity of machinery.

The supply of beets is received from the Santa Maria and Arroyo Grande and adjacent smaller valleys. The total area of good beet land is estimated by the company as about 100,000 (?) acres.

PLATE XIII. BETTERAVIA BEET-SUGAR FACTORY. CAPACITY, 500 TONS.

The Santa Maria Valley lies in the northern portion of Santa Barbara County, and together with Lompoc, Los Alamos, and Santa Ynez, all smaller valleys, comprise the main part of the acreage in the county. The southern part of the county is called the Santa Barbara Valley in general, and comprises Carpinteria, Montecito, Goleta, and Ellwood. It is from the northern part of the county that the beets are received. The soils of the valley have a reddish sandy and gravelly character from Fugler's Point westward to within four miles of the town of Santa Maria, where they change to a grayish character. Still westward toward the sugar factory they become more loamy in character, and it is upon these loam soils that the best results with beets have been secured.

This loam soil with proper moisture should be productive of all crops suitable to that climate, for it is well supplied with potash, phosphoric acid, and humus. Its lime content is somewhat low.

Abundance of water lies at a depth of from 40 to 75 feet, but can not be had as flowing artesian water. If irrigation is practiced it must be by pumping.

The valley of Arroyo Grande, in the southern part of San Luis Obispo County, is noted among seedsmen of the United States as being capable of producing seeds of maximum value. The soil for the most part is a heavy dark clay, gradually becoming more sandy until it finally ends in the sandhills of the coast. The water capacity of the land is very great, reaching as high as 77 per cent by weight. The soil is very rich in all the elements of plant food.

The climatic conditions in these regions do not differ materially from those described for other sections of southern California, except perhaps having a somewhat greater rainfall than those in the extreme south, which, taken together with the high moisture-holding power of the soil, particularly in the Arroyo Grande Valley, is particularly favorable.

With the other factories in the southern area this factory suffered much from the drought years of 1899 and 1900. While 6,500 acres of beets were planted the first year and the early part of the season looked very favorable, later the conditions became such that but 3,500 acres were harvested, which gave but 16,000 tons of beets, and the factory ran but 58 days. The season of 1900 gave correspondingly low returns, but in 1901 conditions were more nearly normal, and from 3,461 acres were produced 35,898 tons of beets, or 10.36 tons per acre, with a sugar content of 15 per cent and a purity of 80, giving the factory a run of 95 days. A tabulated statement of the factory operations is shown below:

TABLE XII.

BETTERAVIA FIELD AND FACTORY STATISTICS, 1899-1902.

	1899	1900.	1901.	1902.
Acres of beets harvested	3,638	2,933	3,461	3,192
Tons of beets produced	16,664	12,419	35,898	37,218
Average yield per acre, tons	4.58	4.23	10.36	11.70
Total amount paid farmers for beets	$71,655	$49 676	$166,131	.....
Average per ton	$4 30	$4 00	$4 60	.....
Sugar in beets, per cent	15.7	17.7	14.9	15.7
Purity coefficient	77.0	81.0	79.8	78.6
*Crude sugar per acre, lbs.	1,438	1,497	3,087	3,680
*Refined sugar per acre, lbs.	1,150	1,198	2,470	2,944
*Crude sugar per ton of beets, lbs.	314	354	298	314
*Refined sugar per ton of beets, lbs.	251	283	236	251
Campaign began	Sept. 20	Sept. 10	Sept. 3	July 21
Campaign closed	Dec. 6	Nov. 10	Dec. 19	Nov. 4
Length of campaign, days	77	61	106	106
Average returns per acre	$19 69	$15 92	$47 66	.....

*Estimated by the writer.

At present the company itself grows about one half of its supply of beets on owned or rented land. Land for beet-growing rents for from $6 to $8 cash, or from one fifth to one fourth the crop, and ranges in price from $75 to $150 per acre.

It would hardly be just to the region to make any comparison of returns per acre, for two out of the three years during which the factory has operated the climatic conditions have been worse than any previous ones in the history of the State. With anything like a favorable year the locality is sure to give both excellent yields and good quality of beets, which was well illustrated in 1901 and is again evidenced this season, the crop being estimated at about 40,000 tons from about 4,000 acres.

GENERAL CONSIDERATION OF THE SUGAR INDUSTRY.

Advantages Accruing from Beet Culture.—Collecting some of the more important items for a more comprehensive view of the status of the industry in the State in general, particularly upon the agricultural side since 1888, we find that on a total of 326,000 acres there has been an average production of 9.8 tons of beets per acre annually, giving an average return of over $44 per acre, or a net profit of about $14 per acre, which certainly compares favorably with other crops grown in the State. A like number of acres devoted to wheat and most other agricultural crops for the same period would have produced a decidedly less return per acre, if average price and yield per acre be taken as the basis.* The figures above stated can not be taken as the entire value, for there should be included the better condition in which the land is left for the growth of other crops, provided the beet crop is properly handled by returning the tops to the field either by plowing-under or feeding them and returning the manure to the field. This, of course, is difficult to express in money value. It is pertinent, however, to say that in Europe the increased production of cereals resulting from beet culture has been shown to be very material, as will appear below.

The ten-year average crop from a 625-acre farm growing cereals was 5,736 bushels of grain before beet culture was introduced. After beet culture was introduced 125 acres were planted each year with sugar beets; the average crop of grain from the remaining 500 acres was 5,730 bushels yearly, being a clear gain of the product from 125 acres. Thirty-five other farms showed the following increase after the introduction of beet culture, in a ten-year average:

* As against the above figure it is notable that the gross return from all cultivable land in this country in 1901 was less than $10 per acre, and for cereals was but a little over $8 per acre; while crops of beets yielding as high as $25 to $30 per acre were not at all uncommon.

TABLE XIII.

SHOWING INCREASE IN VARIOUS CROPS DUE TO INTRODUCTION OF BEET CULTURE.

	Average Pounds per Acre.		
	Before.	After.	Increase.
Wheat	1,848	2,128	280
Rye	1,456	1,672	116
Barley	1,672	2,094	322
Oats	1,355	1,918	563
Peas	985	1,834	949
Potatoes	11,716	13,569	1,853

It is said that there has been an increase of about 21 per cent in all crops in Germany and Austria-Hungary in consequence of sugar-beet culture.

There would seem to be four very valid reasons why farmers should turn more attention to the beet crop:

1. It is a cash crop, with a price practically fixed.

2. It is one of the surest crops a farmer can grow, if given the requisite care.

3. There is more money in it than in most other crops, if it be grown under proper conditions.

4. It increases the production of other crops, because of the deeper cultivation.

The business has often been given a setback in new regions by the too ardent claims of promoters, who have either encouraged the growing of beets upon soils not at all adapted to the crop, or have encouraged farmers, entirely ignorant of its exacting requirements, to contract for a much larger acreage than they could possibly handle, the inevitable result being failure and disappointment. These failures do not at all reflect upon the industry as such, but are causes of serious loss to both factory and farmer. It is far better for a factory to have a smaller acreage grown, and have it grown successfully, than to have a large one coupled with a partial failure. This matter is particularly pertinent in localities where the industry is being inaugurated, and should receive the most careful attention of managers of new factories. A factory has a much brighter prospect for ultimate success if it secures few acres distributed among a large number of small farmers than with a larger number of acres grown by a few contractors. This is one of the potent reasons of the success in Utah. The industry is notably one for the small farmer, who should be encouraged to turn attention to the crop as generally a remunerative one; but there is no royal road to riches, even through the sweetness of the sugar beet.

A Review of the 1901 Campaign.—The season of 1901 may be considered as having been generally favorable to the industry not only in California but elsewhere as well. Below will be found a table showing

TABLE XIV.

COMPARATIVE BEET-SUGAR STATISTICS FROM SEVERAL STATES.

STATE.	Acres of Beets.	Tons of Beets Worked.	Total Sugar Produced.	Total Cost of Beets.	Average Yield per acre. Tons.	Average Cost per Ton.	Quality.		Sugar per Acre, lbs.	Sugar per Ton, lbs.	Average Return per Acre	Tons Beets to One Ton Sugar.	Character of Season.
							Average Sugar.	Average Purity.					
California	57,979	643,454	143,947,800	$2,895,545	11.09	$4 50	15.9	80.8	2,482	224	$49 94	8.9	Fair.
Michigan	59,949	507,865	106,207,500	2,285,392	8.47	4 49	14.2	82.6	1,772	209	38 12	9.5	Fair.
Colorado	19,669	192,629	47,411,600	866,830	9.79	4 50	17.1	83.0	2,410	246	44 06	8.1	Good.
Utah	12,506	143,296	30,710,000	644,698	11.45	4 50	14.0	82 9	2,455	214	51 55	9.3	Fair.
Nebraska	7,917	70,110	14,912,300	315,496	8.86	4 50	13.1	79.3	1,883	212	30 98	9.4	Fair.
Washington	1,500	10,500	2,200,000	47,250	7.00	4 50	17.0	85.0	1,467	209	31 50	9.5	Fair.
Oregon	2,300	12,719	3,066,000	57,236	5.53	4 50	16.0	85.0	1,333	241	20 53	8.3	Fair.
New York	5,993	46,600	9,337,983	209,700	7.77	4 50	13.7	83.4	1,558	200	34 99	9.9	Fair.
Ohio	1,800	12,300	2,492,000	55,350	6.83	4 49	12.7	76.2	1,384	202	30 75	9.8	Poor.
Wisconsin	2,470	18,245	3,466,550	82,102	7.39	4 50	14.8	82.3	1,403	190	33 23	10.5	Poor.
Minnesota	3,200	28,000	5,400,000	126,000	8.75	4 50	14.0	81.0	1,687	193	39 37	10.3	Good.

TABLE XV.

FACTORY OPERATING-STATISTICS, BY STATES—CAMPAIGN OF 1901.

STATE.	Beets Worked.		Fuel Used.				Limestone.		Labor, Factory.	Cost per Ton.				
	Tons.	Cost.	Coal.		Oil.		Tons.	Cost.		Beets.	Labor.	Coal.	Oil.	Lime-stone.
			Tons.	Cost.	Barrels.	Cost.								
California	643,454	$2,895,545	7,400	$22,200	669,509	$234,327	76,640	$153,280	$587,378	$4 50	$0 91.2	$0 88.4	$0 37.9	$0 23.9
Michigan	507,865	2,285,392	103,250	306,750	.....	.....	44,971	84,942	553,648	4 49	1 09.0	50.4	.....	17.7
Colorado	192,629	866,830	43,912	128,736	.....	.....	15,115	30,230	201,404	4 50	1 04.5	66.3	.....	16.5
Utah	143,396	644,698	21,002	63,006	.....	.....	7,882	15,754	93,372	4 50	65.1	1 47.0	.....	10.8
Nebraska	70,110	315,498	15,006	45,018	.....	.....	8,878	17,756	73,844	4 50	1 05.3	43.3	.....	25.3
Washington	10,500	47,250	1,375	4,125	.....	.....	850	1,700	12,150	4 50	1 15.7	39.3	.....	16.2
Oregon	12,719	57,236	.....	.....	.....	.....	780	1,560	16,000	4 50	1 25.8	.....	.....	12.3
New York	46,600	209,700	7,933	23,799	.....	.....	2,894	5,788	34,790	4 50	70.4	51.1	.....	12.4
Ohio	12,300	55,350	3,300	9,900	.....	.....	1,035	2,070	20,000	4 50	1 62.6	59.2	.....	16.8
Wisconsin	18,245	82,102	3,101	9,303	.....	.....	1,277	2,554	38,016	4 50	2 08.4	51.0	.....	14.0
Minnesota	28,000	126,000	5,950	17,850	.....	.....	3,000	6,000	36,000	4 50	1 28.6	63.8	.....	21.4

collective results for the California factories for that year and also similar results for factories in other States. It will be noted that the conditions are generally reported as fair, and especially is this true for the leading sugar-producing States—California, Michigan, Colorado, and Utah. Although the results are reduced to average per ton or acre, as the case may be, yet it is hardly just to compare the States having but a limited acreage and but a single factory with those where several factories are located. For the sake of complete records, however, the figures from all the States are included.

It will be noted that Michigan cultivated a larger number of acres than California, but the total tons of beets produced was less by 35,000. In the average yield per acre California with 11.09 tons is surpassed only by Utah with 11.45 tons, and if we exclude the two localities in California in which the conditions are reported as *poor*, it would give her an average of 12.6 tons per acre, or an average of one ton per acre more than produced in any other State, which may be taken as a fair index of her producing power *when moisture conditions are at all favorable.*

To maintain her high producing power attention must be given to the matter of irrigation; it is the only way in which the fickleness of climate can be overcome. Given climate, and the farmer is largely independent of the soil question when rational methods of culture are observed.

It is interesting to note that the average price per ton is the same in all States, $4.50. But in this connection it should also be noted that the Eastern factories are paying more for their raw material, when the quality is considered; in other words, it is costing them more per ton of sugar.

When the season's returns per acre to the farmer be considered, Utah with $51.55, again is the only State which exceeds California with $49.94, but it has probably cost her that much more to irrigate her land, this extra cost, however, being well spent in order to make sure of a crop, a condition which is devoutly to be wished for in California. Given a favorable season, and there is probably not a State that can surpass California (even if any can equal her) in the number of tons of high-grade beets that can be produced per acre.

The Cost of Manufacture.—Turning attention to a phase of the industry which appeals to the business man, we find that 643,454 tons of beets produced 71,974 tons of sugar, or 8.9 tons of beets to one ton of sugar. The cost of producing this sugar for each factory can not be exactly stated, nor would it be just to the individual factory to do so. Attention should be called, however, to some figures along this line that recently appeared in the report of Mr. C. F. Saylor on "The Progress of the Beet-Sugar Industry in the United States for 1901," page 36, under the head "Cost of working one ton of beets," from which very

erroneous conclusions might be drawn. The writer there states only the cost of labor (factory), fuel, and limestone, mentioning no other items which enter into the cost of working a ton of beets, and leading one to infer that from these items we might arrive at a close estimate of the cost of making one ton of sugar. A practical factory man, however, knows that this does not include many items which always enter into the cost of sugar production. Any just estimate must include many other things which involve a heavy annual outlay and must be charged to the season's run. Among these are sacks, coke, filter cloth, knives, oil, soda, tallow, acid, and repairs, all of which would easily amount to 50 cents per ton of beets.

Limiting ourselves to California conditions and basing our figures now *simply on the handling of the beets in the mill*, the statement of *factory expenses* would stand about as follows:

	Per Ton of Beets.
Labor	$0.912
Fuel	.379
Limestone	.239
Miscellaneous supplies	.500
	$2.030
Cost of beets	4.500
	$6.530

While the above expresses in a very general way the factory expenses, yet, as a matter of fact, there are still other items which must be included, for, outside of a company's field operation, the cost of manufacture must actually stand a certain allowance for depreciation and changes, which is usually considered to be about 7 per cent on the original cost, or $1.089 per ton of beets; there must also be added at least 80 cents per ton of beets for interest, taxes, and insurance, and approximately 5 cents per ton for selling expense. This makes a total of $8.469 per ton of beets, or according to the figures for the tons of beets per ton of sugar, $74.37 per ton of refined sugar.

In connection with the above some researches of Mr. Paul Doerstling, a well-known German authority and contributor to American and European sugar journals, into the cost of sugar production in various countries, is interesting. Mr. Doerstling's compilation shows as follows:

BEET SUGAR.

	Tons Beets per Acre.	Tons Sugar per Acre.	Cost of Sugar per Ton.
Germany	12.5	1.2	$49 00
Austria	9.3	1.1	47 00
France	10.9	1.2	56 00
Russia	7.2	0.8	60 00
General average	10.0	1.07	$53 50

CANE SUGAR.

	Tons Cane per Acre.	Tons Sugar per Acre.	Cost of Sugar per Ton.
Spain	17	0.9	$55 00
Japan	15.5	1.3	78 00
Java	32	3.0	38 00
Straits Settlement	20	1.6	41 00
Egypt	19	1.9	45 00
Reunion	21	1.9	60 00
Louisiana	22	1.9	75 00
Cuba	24	1.8	40 00
East Indies	....	1.0	36 00
Hawaii	22	2.8	30 00
Argentina	13	1.0	62 00
British West Indies	....	1.7	47 00
Queensland	...	1.7	29 00
Porto Rico	20	2.0	28 00
General average	20	1.75	$62 00

Mr. Doerstling's figures refer to the manufacture of *raw* sugar, and to make them comparable with those for California, must have the cost of refining added.

The selling price of this sugar in 1901 did not vary much from $80 per ton, thus giving a profit of only about $5.63 per ton, or a total profit of but $405,213, or about 4 per cent on the investment in the factories in the State, which, under fair years of production, may be considered a minimum, as sugar has ruled at its lowest figure during this period. With sugar at 5 cents it would mean about 18 per cent, which, when all attendant risks are considered, can not be considered excessive. It should be stated, however, that so favorable a season as 1901, and a high average price for sugar, do not often occur together, and that even in favorable seasons this higher profit should be cut in two as representing fair average returns to the factory.

It should be distinctly understood that in this estimate there is drawn a sharp distinction between the purely manufacturing and the agricultural operations which are often conducted by the companies themselves and enter into any final profit or loss to the company. The growing of sugar beets is distinctly a business for the small farmer, and it is very questionable whether any company can produce beets as cheaply, even under the most favorable conditions, as can the individual grower with a smaller acreage, and consequent closer supervision of work. With the least laxity in supervision it becomes a very easy matter for a company to lose in the field all that is really made in the factory, and the manufacture of sugar forced to bear the burden of field losses. The economic *production* of sugar in the field is a far more intricate matter than the *extraction* of it in the factory, and demands an entirely separate consideration.

Often it is not considered that the profit from the manufacture of sugar may be materially influenced after the crop is grown, and especially so in case a flat price is paid for the beets, which practice much prevails in this State. Warm, moist weather during harvest time—a condition which not infrequently obtains in the northern part of this State—invariably causes a serious loss in sugar. A case in point is stated by one of the factories:

AVERAGE PERCENTAGE OF SUGAR IN BEET.

1894—September	13.6
October	12.8
November	10.8
December	10.5

While in the same months the year previous the figures were 13.4, 14.4, 14.7, 14.9.

When all things are considered, it must be admitted that when a flat price of $4.50 per ton is offered for beets the factory is offering as large a price as it can afford with sugar as fluctuating as it has been in recent years, and with political conditions as unsettled in the sugar world as they are at the present time.

A careful survey of the conditions as they exist to-day can lead to but one conclusion, viz., that the industry is generally in a healthy status from both the manufacturing and the agricultural standpoints, and that the only thing which can possibly prevent California from ultimately maintaining her position as the leading beet-sugar-producing State is the fickleness of her climate with respect to moisture, or unfavorable Congressional action. With a more extensive introduction of irrigation into her agricultural and horticultural practice this single drawback will disappear, and we may reasonably expect to see a great expansion of the industry.

The capital necessary for building factories is abundant. There are perhaps now in this country several million dollars awaiting investment in beet-sugar factories just as soon as investors can be assured of the coöperation of farmers in suitable localities.

Not California alone, but the entire country is interested in the permanent establishment of the beet-sugar industry in those districts which are best adapted for it, and under those conditions which will best conduce to the upbuilding of a prosperous trade.

What California Can Do in Beet Sugar.—It is not the purpose to discuss the individual localities in California which may be suitable for the location of factories. Numerous localities, however, are known to possess the requirements for success in the industry. In a very general way we may say, quoting Professor Hilgard in "Pacific Rural Press," December, 1897, that "the total valley areas of this State exceed 12,000,000 acres. Estimating the sugar product per acre at the reasonable rate of

1¼ tons of sugar per acre, it would require only 1,125,000 acres, or less than one tenth of the entire valley area, to produce the 2,000,000 tons of sugar estimated to be the present annual consumption of the United States. But with the successful use of irrigation, a considerably larger proportion than this consists of lands intrinsically suitable for sugar-beet culture, so as to admit also of a proper rotation of crops. California alone, then, could readily supply the entire present and prospective sugar consumption of the United States, and still leave ample room for orchards and vineyards and the production of the home supply of breadstuffs. It is perhaps not probable or desirable that this one branch of production should be pushed to this extent; but it would be strange indeed if, with such extraordinary climatic advantages, it failed to attain a more prominent and lucrative position among the agricultural industries of California than at the present time. Climatic considerations as well as soil quality point especially to the valleys of the coast region, from Mendocino to Los Angeles, and the Sacramento and lower San Joaquin valleys, as adapted to it. Excessive heat and dryness in summer are unfavorable for the preservation of that crispness which is deemed essential in a first-class sugar beet. All the essential conditions of success in its cultivation seem to be combined in a large portion of the 'Alameda plains' and other level or gently sloping lands of the Bay coast region, and Sacramento and Salinas valleys, where the lighter sediment soils prevail, and where at present cereal culture, or that of fruit, constitutes almost the only alternative. Southern California, also, has given excellent results as regards both quality and quantity of the sugar-beet crop, in the Chino and Santa Ana regions; and Ventura and San Luis Obispo can with certainty count on a similar outcome. As to the San Joaquin Valley, the sugar beet can probably be grown successfully, without irrigation, on suitable lands as far south as Merced"; with the development of irrigation systems the area could be considerably extended.

The promise of permanence given by this valuable industry makes it desirable that everything possible should be done to safeguard and cherish it as one of the chief resources of California.

REPORTS AND BULLETINS AVAILABLE FOR DISTRIBUTION.

REPORTS.

1896. Report of the Viticultural Work during the seasons 1887-93, with data regarding the Vintages of 1894-95.

1897. Resistant Vines, their Selection, Adaptation, and Grafting. Appendix to Viticultural Report for 1896.

1898. Partial Report of Work of Agricultural Experiment Stations for the years 1895-96 and 1896-97.

1900. Report of the Agricultural Experiment Stations of the University of California for the year 1897-98.

BULLETINS.

No. 121. The Conservation of Soil Moisture and Economy in the Use of Irrigation Water.
125. Australian Saltbush.
127. Bench-Grafting Resistant Vines.
128. Nature, Value, and Utilization of Alkali Lands.
129. Report of the Condition of Olive Culture in California.
131. The Phylloxera of the Vine.
132. Feeding of Farm Animals.
133. Tolerance of Alkali by Various Cultures.
134. Report of Condition of Vineyards in Portions of Santa Clara Valley.
135. The Potato-Worm in California.
136. Erinose of the Vine.
137. Pickling Ripe and Green Olives.
138. Citrus Fruit Culture.
139. Orange and Lemon Rot.
140. Lands of the Colorado Delta in Salton Basin, and Supplement.
141. Deciduous Fruits at Paso Robles.
142. Grasshoppers in California.
143. California Peach-Tree Borer.
144. The Peach-Worm.
145. The Red Spider of Citrus Trees.
146. New Methods of Grafting and Budding Vines.
147. Culture Work of the Substations.
148. Resistant Vines and their Hybrids.

Copies may be had by application to the Director of the Experiment Station.